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DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)  
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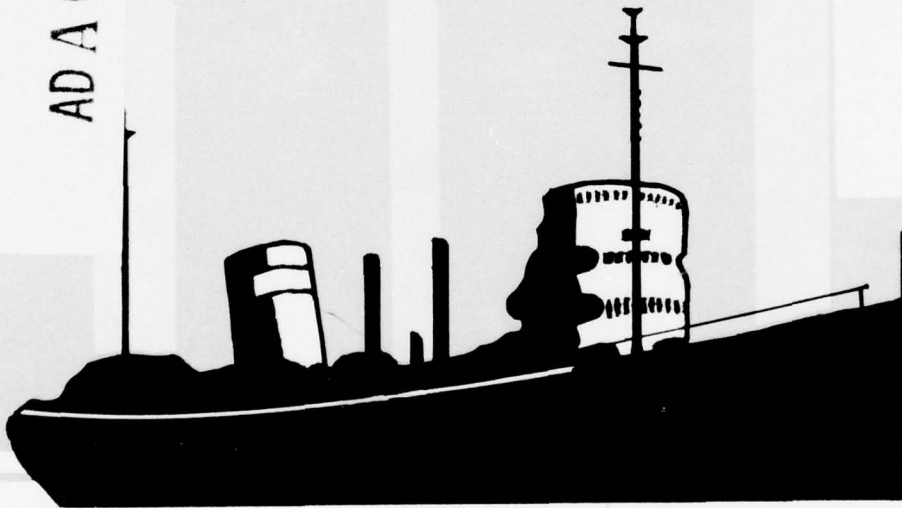


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# DREDGE DISPOSAL STUDY

ADA 043 790

## SAN FRANCISCO BAY AND ESTUARY



### APPENDIX E

### MATERIAL RELEASE

AUGUST 1977

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) → The report presents the results of sediment circulation studies in the northern portion of San Francisco Bay. Work included the development of a numerical model and the conduct of a long term sediment tracer study using neutron activation methods. The tracer program used quantitative techniques to measure the vertical distribution of dredged sediments at select stations covering a 100-square mile area over a ten-month period.		

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DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY

APPENDIX E

MATERIAL RELEASE

AUGUST 1977



U.S. Army Engineer District, San Francisco  
Corps of Engineers  
211 Main Street  
San Francisco, California 94105

## FOREWORD

In April 1972, the San Francisco District of the United States Army Corps of Engineers initiated a study to quantify the impact of dredging and dredged sediment disposal operations on the environment of San Francisco Bay and Estuary. The study has generated factual data, based on field and laboratory studies, needed for the Federal, State and local regulatory agencies to evaluate present dredging policies and alternative disposal methods.

The study was set up to isolate the questions regarding the environmental impact of dredging operations and to provide answers at the earliest date. The study was organized to investigate (a) the factors associated with dredging and the present system of aquatic disposal in the Bay, (b) the condition of the pollutants (biogeochemical), (c) alternative disposal methods, and (d) dredging technology. The study elements were intended first, to identify the problems associated with dredging and disposal operations and, second, to address the identified problems in terms of mitigation and/or enhancement. The division into separate but inter-related study elements provided a greater degree of expertise and flexibility in the Study.

This report Appendix E, Material Release, presents the findings of studies on the long term movement of sediments. The overall study is the basis for the composite Environmental Impact Statement for Dredging Activities in the San Francisco Bay System.

The following is an index of appendices in the Dredge Disposal Study:

<u>APPENDIX</u>	<u>REPORT</u>	<u>DATE PUBLISHED</u>
-	MAIN REPORT	February 1977
A	Main Ship Channel (San Francisco Bar)	June 1974
B	Pollutant Distribution	
C	Water Column (Water Column-Oxygen Sag)	April 1976
D	Biological Community	August 1975
E	Material Release	August 1977
F	Crystalline Matrix	July 1975
G	Physical Impact	July 1975
H	Pollutant Uptake	September 1975
I	Pollutant Availability	October 1975
J	Land Disposal	October 1974
K	Marsh Development	April 1976
L	Ocean Disposal	September 1975
M	Dredging Technology	September 1975

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## CONVERSION FACTORS

If conversion between Metric and British systems is necessary, the following factors apply:

### LENGTH

1 kilometer (km) =  $10^3$  meters = 0.621 statute miles = 0.540 nautical miles  
1 meter (m) =  $10^2$  centimeters = 39.4 inches = 3.28 feet = 1.09 yards = 0.547 fathoms  
1 centimeter (cm) = 10 millimeters (mm) = 0.394 inches =  $10^4$  microns ( $\mu$ )  
1 micron ( $\mu$ ) =  $10^{-3}$  millimeters = 0.000394 inches

### AREA

1 square centimeter (cm<sup>2</sup>) = 0.155 square inches  
1 square meter (m<sup>2</sup>) = 10.7 square feet  
1 square kilometer (km<sup>2</sup>) = 0.386 square statute miles = 0.292 square nautical miles

### VOLUME

1 cubic kilometer (km<sup>3</sup>) =  $10^9$  cubic meters =  $10^{15}$  cubic centimeters = 0.24 cubic statute miles  
1 cubic meter (m<sup>3</sup>) =  $10^6$  cubic centimeters =  $10^3$  liters = 35.3 cubic feet = 264 U.S. gallons = 1.308 cubic yards  
1 liter =  $10^3$  cubic centimeters = 1.06 quarts = 0.264 U.S. gallons  
1 cubic centimeter (cm<sup>3</sup>) = 0.061 cubic inches

### MASS

1 metric ton =  $10^6$  grams = 2,205 pounds  
1 kilogram (kg) =  $10^3$  grams = 2.205 pounds  
1 gram (g) = 0.035 ounce

### SPEED

1 knot (nautical mile per hour) = 1.15 statute miles per hour = 0.51 meter per second  
1 meter per second (m/sec) = 2.24 statute miles per hour = 1.94 knots  
1 centimeter per second (cm/sec) = 1.97 feet per second

### TEMPERATURE

Conversion Formulas  $^{\circ}\text{C} = \frac{^{\circ}\text{F} - 32}{1.8}$   $^{\circ}\text{F} = 1.8(^{\circ}\text{C}) + 32$

DREDGE DISPOSAL STUDY  
SAN FRANCISCO BAY AND ESTUARY

APPENDIX E  
MATERIAL RELEASE

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# DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY

## APPENDIX E

### MATERIAL RELEASE

#### INTRODUCTION

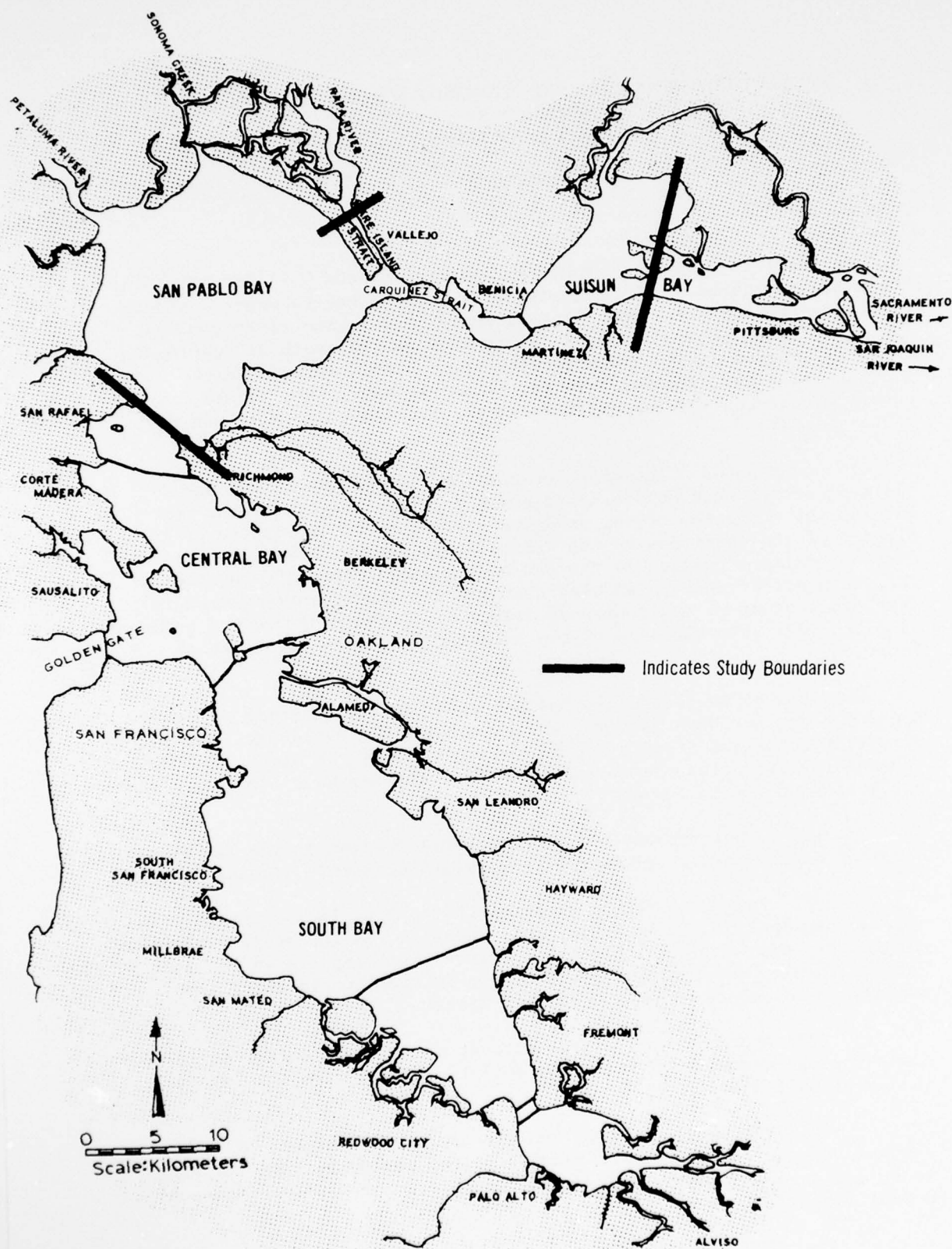
##### OBJECTIVE

In April 1972 the San Francisco District of the U.S. Army Corps of Engineers initiated a comprehensive study on the environmental impacts resulting from dredging and disposal operations in San Francisco Bay. The study requirements included information on the sediment loading in the water column due to dredging with open water disposal and the assimilation of these sediments into San Francisco Bay. This report discusses studies on the long-term sediment circulation in northern San Francisco Bay.

The continuous maintenance of navigable waterways in a dynamic sediment system such as San Francisco Bay raises many questions regarding the economics of the dredging operation and the sphere of influence of the operation on the marine environment. Previous estimates of mass sediment balance in the Bay have assumed that fifty percent of the sediments dredged in shoaled channels are subsequently redredged. Thus, this study of environmental impact of circulating dredged sediment also includes an evaluation of the efficiency in terms of disposal location.

The area of San Francisco Bay selected for the Material Release Study was the northern portion, which includes San Pablo Bay, Carquinez Strait, Mare Island Strait, and Suisun Bay as shown in Figure 1. The reasons for selecting the northern reach of the Bay as a study area was predicated on the following:

- (1) About one-half of the sediments dredged in the Bay by the Corps of Engineers are released at the Carquinez Strait disposal site;
- (2) The twice yearly dredging of the Mare Island Strait channel, averaging 2.5 million cubic yards annually, is the subject of major controversy concerning the possible environmental impacts on Bay and Delta fisheries and the possible increase in shoaling in small boat marinas on the south side of Carquinez Strait.
- (3) Approximately eighty percent of sediment inflow to the Bay comes through Carquinez Strait, the outlet of flows from the Central Valley of California;
- (4) The shallow depths and low-energy environment of large expanses of the northern reach provide a long residence time for sediments and an opportunity to study the long-term circulation-resuspension-deposition cycle;



STUDY LOCATION

FIGURE 1

(5) The nodal point of the salt-water wedge moves through Carquinez Strait between San Pablo Bay and Suisun Bay.

The primary objectives of the study were to determine the long-term movement of sediments in terms of the extent and degree of impacts and the efficiency of the disposal operation at the Carquinez site in terms of quantities returning to the channel for dredging. The secondary objective was to provide additional information on the deposition, resuspension and circulation of sediments in an estuarine environment. The objectives dictated that the efforts be long-term, quantitative and predictive to the greatest extent possible.

#### SCOPE OF STUDY

The study included a long-term program to monitor the movement of tagged dredged sediment and a numerical model. For the tracer program, Bay sediments were tagged with iridium and introduced into the system during a routine six week maintenance dredging operation in Mare Island Strait. The study area of about 100 square miles was sampled monthly for ten months using push tube coring techniques. The cores were analyzed by layer to determine the presence of iridium, which in turn was related to the volume of dredged sediments. The numerical model included the development of a dredged sediment dispersion simulation technique which incorporated a sediment transport model into an existing estuary model. Limited testing was conducted using the numerical model. The Committee on Tidal Hydraulics, a Corps of Engineers consulting activity, provided advice and guidance prior to and during the conduct of this investigation.

#### BACKGROUND

##### SAN FRANCISCO BAY

San Francisco Bay is an estuary. Geomorphologically it is a semi-enclosed drowned valley through which passes the drainage of the Central Basin of California and is subject to tidal action from the adjacent Pacific Ocean debouching through the Golden Gate. The estuary has a bifurcation landward of the Golden Gate with a southerly arm stretching about 35 miles to the southeast and a northerly arm that extends about 22 miles north, then abruptly turns in an easterly direction for about 20 miles to the Sacramento-San Joaquin Delta. The southern arm is South San Francisco Bay and the northern arm passes through Central San Francisco Bay and includes San Pablo Bay, Carquinez Strait and Suisun Bay (see Figure 1). This system of bays has widths of up to 12 miles, and encloses an area of 396 square miles at mean lower low water, and 460 square miles at mean higher high water. San Francisco Bay proper ranges in depth from the shoal areas near shore (less than 15 feet) to the 382-foot depth at the Golden Gate. San Pablo Bay, which is considerably shallower than San Francisco Bay proper, ranges in depth from extensive shoal areas (northern shallows approximately 5 feet) to 94 feet in San Pablo Strait. Of the total Bay system about 50 percent is less than 10 feet deep and about 68 percent is less than 20 feet deep measured from mean sea level.

The University of California Berkeley conducted a comprehensive study of San Francisco Bay from July 1960 to July 1964 in which the Bay's hydrologic system was characterized (1). They found that the mean annual rates of total advective flow during the survey period were -77 and +20,070 cubic feet per second (cfs) in the southern and northern reaches, respectively. The maximum observed positive and negative monthly flow rates were 2,230 and -1,320 cfs in the southern reach and 101,400 and -480 cfs in the northern reach. The southern reach was generally a neutral arm because of the relatively insignificant advective flow in the region. The northern arm, however, was a significantly positive system during most of the survey period as a result of the Delta outflow. From Corps studies (2) the mean annual tidal prism of the southern reach was about  $3 \times 10^{10}$  cubic feet. This value was about thirty percent greater than the number of cubic feet determined for the northern reach. Using tidal wave amplitudes, amplitude time lags, and phase shifts it was concluded that the tidal wave was predominantly a standing wave in the southern arm and a progressive wave undergoing extensive frictional decay in the northern arm. The magnitude of the advective flows significantly influences the characteristics of this northern tidal wave.

The tides provide a major portion of the turbulent energy-causing estuarine mixing (3). Secondary sources of turbulence include river inflow, currents generated by lateral constrictions of bottom configuration and wind-wave phenomena. The degree of turbulence in an estuary dictates the distribution of water properties. Estuarine mixing structure has been classified in terms of salinity as (a) vertically mixed or well-mixed, (b) slightly stratified or partially mixed, and (c) highly stratified (4). For low freshwater inflows (5,000 to 10,000 cubic feet per second), all portions of the Bay system are classified as well-mixed. For inflows of 100,000 cubic feet per second the Golden Gate and extreme South Bay areas remain well-mixed, but mid-South Bay, San Pablo Strait and Carquinez Strait areas change to a partly mixed condition. In the area above Carquinez Strait the flow is highly stratified. For an inflow of 200,000 cubic feet per second, there is no evidence of a well-mixed condition anywhere in the Bay system. A major part of the system is partly mixed and a highly stratified condition extends far downstream from the head of Suisun Bay to and beyond Carquinez Strait (2). Thus, the San Francisco Bay system is not a single well-defined body of water.

Inflow into the Bay system through Suisun Bay primarily stems from the two major river systems of the Central Valley Basin - the Sacramento and San Joaquin Rivers. The net delta inflow is estimated to be about 16,800,000 acre-feet per year under present upstream development conditions. Historically, without any flow regulation or diversion, Delta input was estimated to be 30,300,000 acre-feet per year (4). In addition to the Sacramento and San Joaquin Rivers which drain into the Bay through the Delta, only eight other major tributaries flow into the Bay system. The combined mean annual flow of these streams is less than 500 cubic feet per second (360,000 acre-feet per year). The major portion of the freshwater flow occurs between November and April.

Sediment inflow-outflow and distribution within the Bay System have been variously estimated by Gilbert of the U.S. Geological Survey (USGS) in 1917 (5); Grimm of the Corps of Engineers in 1931 (6); the Soil Conservation Service of the U.S. Department of Agriculture in 1947; the Corps of Engineers in 1954 and 1967 (2,7); State of California Department of Water Resources in 1955; Porterfield, Hawley and Dunnam of the USGS in 1961 (8); Smith of the Corps of Engineers in 1963 (9); and Krone in 1966 (10). These studies vary in their estimates of inflow-outflow and distribution of volumes in the Bay system. The variance can be primarily attributed to a scarcity of data available to the investigators.

Smith, using U.S. Coast and Geodetic Survey charts of the Bay at periodic intervals between 1855 and 1956 and logs of borings, estimated the total deposit of Bay sediments to be 16 billion cubic yards. The deposits were lightest in Suisun Bay, heaviest in Central Bay and roughly equal for the remaining areas. The ratio of deposition per acre is respectively, 1:3:2 for Suisun Bay, the Central Bay, and approximately equal for Carqinez Strait, San Pablo Bay, and South Bay. Generally, these areas have experienced cycles of deposition and erosion, with the greatest deposition taking place during the hydraulic mining era in the Sierra Nevadas. Gilbert estimated that just during the period of 1850-1914, one and one-half billion cubic yards of sediment were deposited in the Bay system.

Estimated annual sediment inflow volumes before 1961 reflect the limited amount of data available at the time. These volumes range from 8.0 million cubic yards predicted by Gilbert to 1.97 million cubic yards estimated by the Corps of Engineers in 1954. The USGS in 1961 was the first to use direct measurements of suspended loads being transported into the Bay system by all sources. From these measurements the USGS calculated the annual sediment inflow to the Bay system between the years 1957-1959 to be 8.8 million cubic yards. From this value they estimated the present annual inflow volume to be 8.0 million cubic yards. Smith in 1963 estimated that 8.325 million cubic yards per annum was the inflow rate to the Bay system. He derived his estimate from tonnages and daily sediment inflows by geographical areas for the years 1909-1959 and adjusted to 1957-1959 conditions. The Corps of Engineers in 1967 used the basic data developed by the USGS for the period 1957-1959 to arrive at the average annual sediment inflow value of 9.56 million cubic yards. The difference in the Corps' 1967 value and the USGS' 1961 value reflect different in-place density values used to convert weight of sediment to volume of shoal. Krone in 1966 estimated the average annual sediment inflows for the Bay system to be 10.5 million cubic yards, based on hydrologic data from 1922-1933 and USGS measurements of suspended sediment for the years 1957-1965. Krone also estimated the projected 1990 and 2020 sediment inflows.

Of the sediment entering the Bay system from natural sources (new fluvial sediments) or from open water disposal of dredged sediment, a portion is transported to the ocean via the Golden Gate and a portion is retained in the Bay system. The Corps of Engineers in 1967 used two methods for determining sediment outflow. The first method, "Historical Shoaling Method," estimated the volume of sediment leaving the Bay as the difference between the sum of the new sediment inflow (10.0 million cubic yards) and dredged sediment released in the Bay (9.6 million cubic yards) and the sum of shoaling within and outside navigation channels and facilities (15.4 million cubic yards). The estimated average annual sediment outflow volume derived from the "Historical Shoaling Method" was 4.2 million cubic yards. The second method, "River Discharge Method," used an estimate of the net water discharge through the Golden Gate and an assumed average turbidity for Bay water. The product of turbidity and net water discharge gave the net sediment outflow. Analysis of numerous suspended sediment samples throughout the Bay system for conditions of low, average and flood flows, indicated that the average turbidity in Carquinez Strait and easterly San Pablo Bay was about 70-80 parts per million, and at the Golden Gate, about 40-50 parts per million. Assuming a turbidity of 50 parts per million for an average monthly discharge of 29,000 cubic feet per second, the Corps of Engineers estimated the average annual outflow to be 3.3 million cubic yards. In addition, model studies indicated that an additional 1.4 million cubic yards would leave the Bay annually from overboard dredge disposal practices, totaling 4.7 million cubic yards.

The Corps of Engineers in 1967 studied the historical sedimentation patterns in the Bay system using hydrographic surveys for a 101-year period from 1855 to 1956. The results of the study showed that there was an average annual net deposition of 5.2 million cubic yards.

Krone, in his sedimentation studies of San Francisco Bay in 1966 and 1974 estimated that 8.1 million cubic yards of sediment annually leaves the Bay, while 2.4 million cubic yards are retained. He estimated that a steady state situation was reached in the Bay-Delta system in about 1957. The annual retention of 2.4 million cubic yards of sediment in the system is compensated for by an average annual rise in sea level of 0.00577 feet per year and gradual subsidence of the Bay bottom (5). The State of California Department of Water Resources (11) estimated annual net deposition in the Bay to be 2.1 million cubic yards. Table 1 is a summary of the average annual sediment inflow-outflow and deposition volumes from the foregoing investigations.

Two other aspects of sediment transport in the Bay system are annual dredging and disposal operations, and resuspension of bottom sediments due to wind-generated turbulence and tidal currents. Approximately 10.5 million cubic yards of Bay sediments are dredged annually in the Bay system. The majority of these sediments are released in the Bay

TABLE 1  
ANNUAL SEDIMENT INFLOW-OUTFLOW AND  
DEPOSITION VOLUMES  
FOR  
SAN FRANCISCO BAY SYSTEM<sup>1/</sup>

	Inflow From Delta	Inflow From Other Tributaries	Total Inflow	Sediment Outflow	Sediment Deposition
Investigator	Millions of Cubic Yards				
Gilbert (1917)					
Prior to 1850	2.0				
1850-1914	23.0				
Future predicted	8.0				
Grimm (1931)	5.75				-5.4*
Corps of Engineers (1954)					
Existing	3.36				
Future w/controls	1.97				
Calif. Dept. of Water Resources (1955)					
Existing conditions	4.0				
Future w/controls	3.0				
U.S.G.S. (1961)					
From 1957-1959	7.2	1.6	8.8		
Future	6.9	1.1	8.0		
Smith (1963)					
1960 conditions	7.04	1.195	8.235	4.2	5.2
Corps of Engineers (1967)					
	8.13	1.43	9.56	4.7	5.2
Krone (1966)					
By year 1960	8.1	2.4	10.5	8.1	2.4
By year 1990	4.3	2.4	6.7		
By year 2020	3.0	2.4	5.4		

\* Considers only San Pablo Bay and Carquinez Strait.

<sup>1/</sup> Source: Dredge Disposal Study, Appendix B.

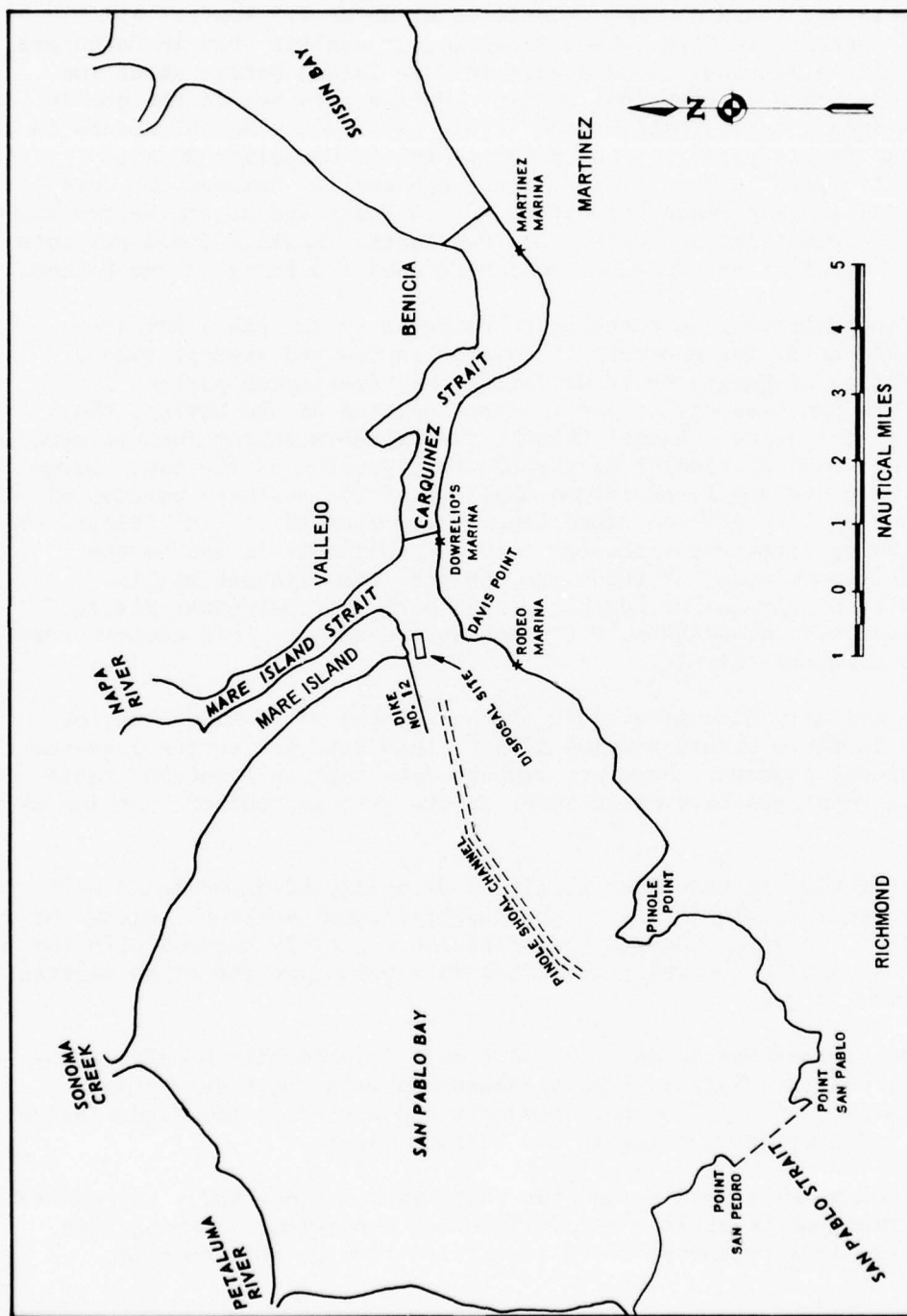
at three open water disposal sites. Assuming that sites received dredged sediments over a 250-day period and that the sediment disperses over a 100-square-mile area, 400 cubic yards of dredged sediment would be placed in suspension per square mile per day of dredging. In contrast, Krone estimated the amount of material suspended by wave action in a square mile of shallow area by conservatively using an average suspended sediment concentration of 0.5 grams per liter over a five-foot water depth when the wind blows over 10 knots. Using the value of 220 days per year when the wind velocity is 10 knots or greater, Krone estimated that each square mile of shallow area suspends 2,200 tons of sediments per day. Using the density of 25 pounds per cubic foot for sediments brought into suspension by wind and wave forces, the 2,200 tons may be converted to cubic yards, giving a total of 6,500 cubic yards per square mile per day as the volume of sediment resuspended by wind-driven waves. This is 16 times the amount calculated for dredging.

#### SAN PABLO BAY-CARQUINEZ STRAIT

Carquinez Strait is the western terminus for water discharge from the Great Basin. The confluence of the San Joaquin and Sacramento Rivers is located just east of Suisun Bay where the river flow then moves into the narrow and deep Carquinez Strait. The Strait is seven and one-half miles long and varies from one-half to one mile in width. Because of the constricted width and high flows, the strait reaches depths of greater than 100 feet. The Napa River discharges into the western end of Carquinez Strait through Mare Island Strait. Carquinez Strait empties into the broad and shallow San Pablo Bay, an area where freshwater inflow from the Great Basin inter-mix with the saline estuarine waters.

San Pablo Bay contains twenty-five percent of the total area of the Bay system. It is roughly circular and shallow, and half the bay is less than six feet deep. Much of the shoreline consists of marshes and tidal flats which are exposed at low tide. A natural channel shown in Figure 2 crosses the southern part of the bay from San Pablo Strait to Carquinez Strait. This channel is greater than 20 feet in depth. A dredged channel, maintained to a depth of 35 feet below MLLW cuts through Pinole Shoal in the eastern half of the natural channel. Another natural channel, somewhat subdued, moves north from San Pablo Strait towards the Petaluma River.

Tides in the deeper channels of the northern Bay system behave as a progressive wave, with about 20 percent attenuation between the Golden Gate and Suisun Bay, due to channel friction. A time lag of tidal phase and currents occur as the tide progresses up San Francisco Bay. As a result slack current in San Pablo Bay may lag behind the time of tidal stand by one to three hours, depending in part on river inflow rates. The magnitude of tidal currents in San Pablo Bay depends on the location



STUDY AREA FOR MATERIAL RELEASE INVESTIGATION.

FIGURE 2

in respect to the channels. In the channels the currents range from 4.2 knots at flood to 5.8 knots at ebb. The tidal currents in shallow areas of San Pablo Bay reach maximum velocities of about 2.5 knots. All phases of currents in Mare Island Strait occur earlier than in Carquinez Strait. On the average, flood occurs in Mare Island Strait about two hours before flood in Carquinez Strait. During this period the ebb in Carquinez Strait enters Mare Island Strait as flood. The ebb occurs in Mare Island Strait about 1.5 hours before ebb in Carquinez Strait. Current velocities in Mare Island Strait are small. Maximum ebb currents at the surface reach velocities of 1.3 knots and at the bottom the ebb current velocities are only about 0.6 knots. Maximum flood currents reach velocities of one knot at the surface and 1.5 knots at the bottom.

The approximate flow circulation patterns in San Pablo Bay are shown in Figure 3, for moderate freshwater inflow and typical tides. The importance of geography in dictating the circulation pattern is evident. The shallowness of the northern portion of the bay and the presence of the deeper channel through the southern sector funnels much of the flood and ebb tidal flow through that portion of the bay. Large eddy currents are developed in the shallows of the northern portion of the bay during both ebb and flood flow. Near the end of tide (Figure 3) flood currents first enter the bay from San Pablo Strait and as the flood gathers momentum, it turns the ebb into the adjacent shallow areas, particularly in the northeast, and back into Carquinez Strait. As the flood tide progresses, the northeastern shallow area contributes flow into Carquinez Strait.

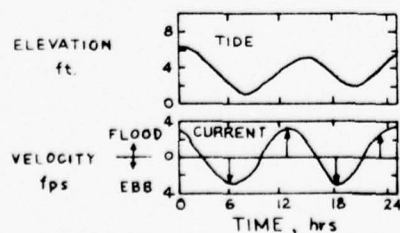
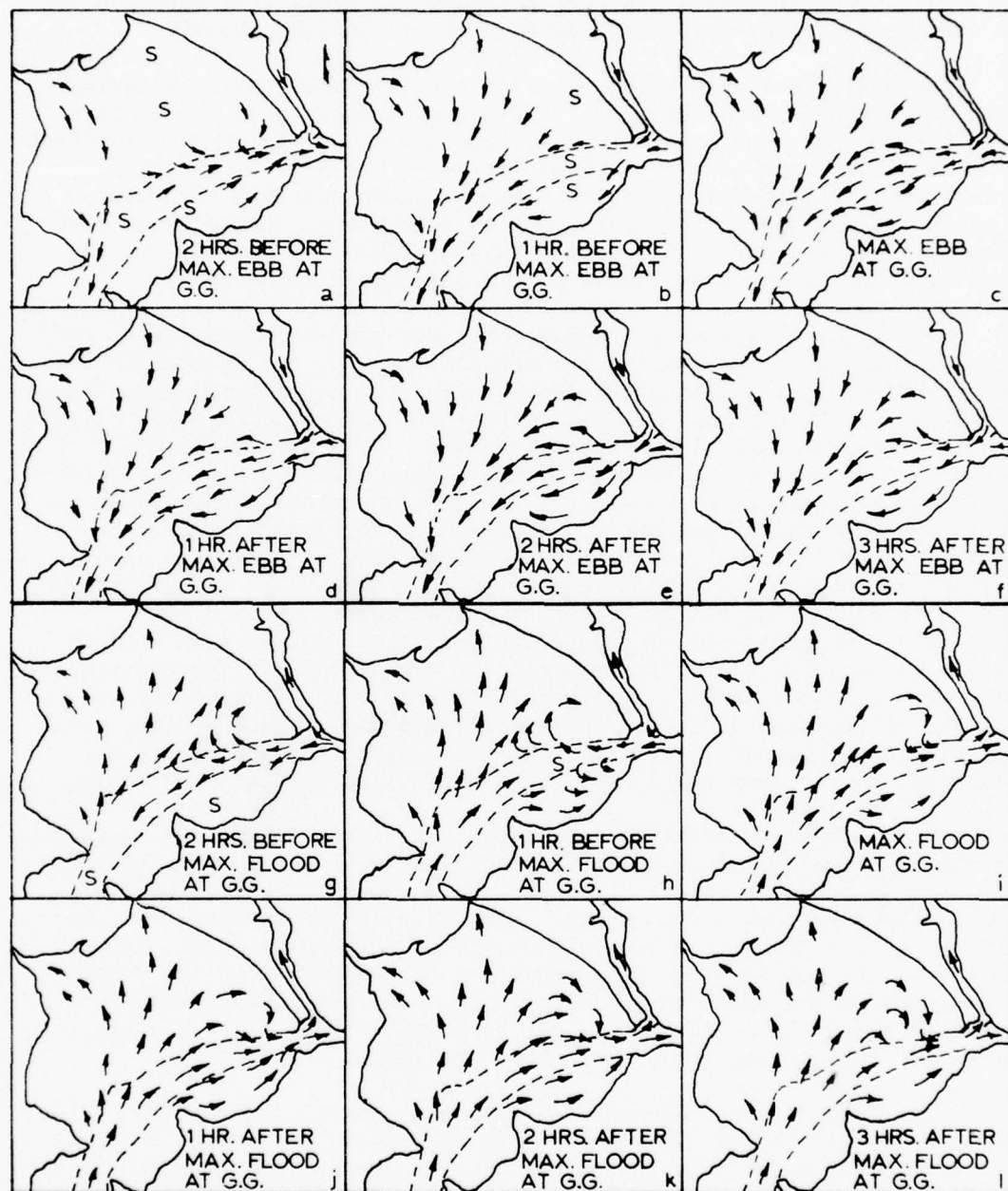
As previously discussed, much of the ebb and flood flows are concentrated in the southern portion of San Pablo Bay, due to the presence of the natural channel. However, promontories such as Point San Pablo and Pinole Point generate small gyres in the extreme southern portion of the bay.

Current flow in Carquinez Strait is primarily bi-directional with the major concentration being in the deeper channel section. Along the periphery of the strait current velocities are greatly subdued with the formation of small, low velocity eddies in areas where the cross section area becomes larger.

Tidal circulation in Mare Island Strait is primarily bi-directional. There exists a bottom flood predominance with the tidal prism filling largely through the bottom waters and a surface ebb predominance with the tidal prism emptying in the surface waters.

San Pablo Bay is well-mixed for most river inflows and partly-mixed during periods of freshwater runoff (freshet condition). During high runoff there is a tendency toward stratified flow in the channels.

# FLOW CIRCULATION IN SAN PABLO BAY



SCHMATIC TIDE-CURRENT RELATION

## NOTES

- = Flow Direction
- S = Slack Current
- = Edge of Deep Water
- GG. = Golden Gate

Described currents are for a mean tide of considerable diurnal inequality and for low river inflow (16,000 cfs)

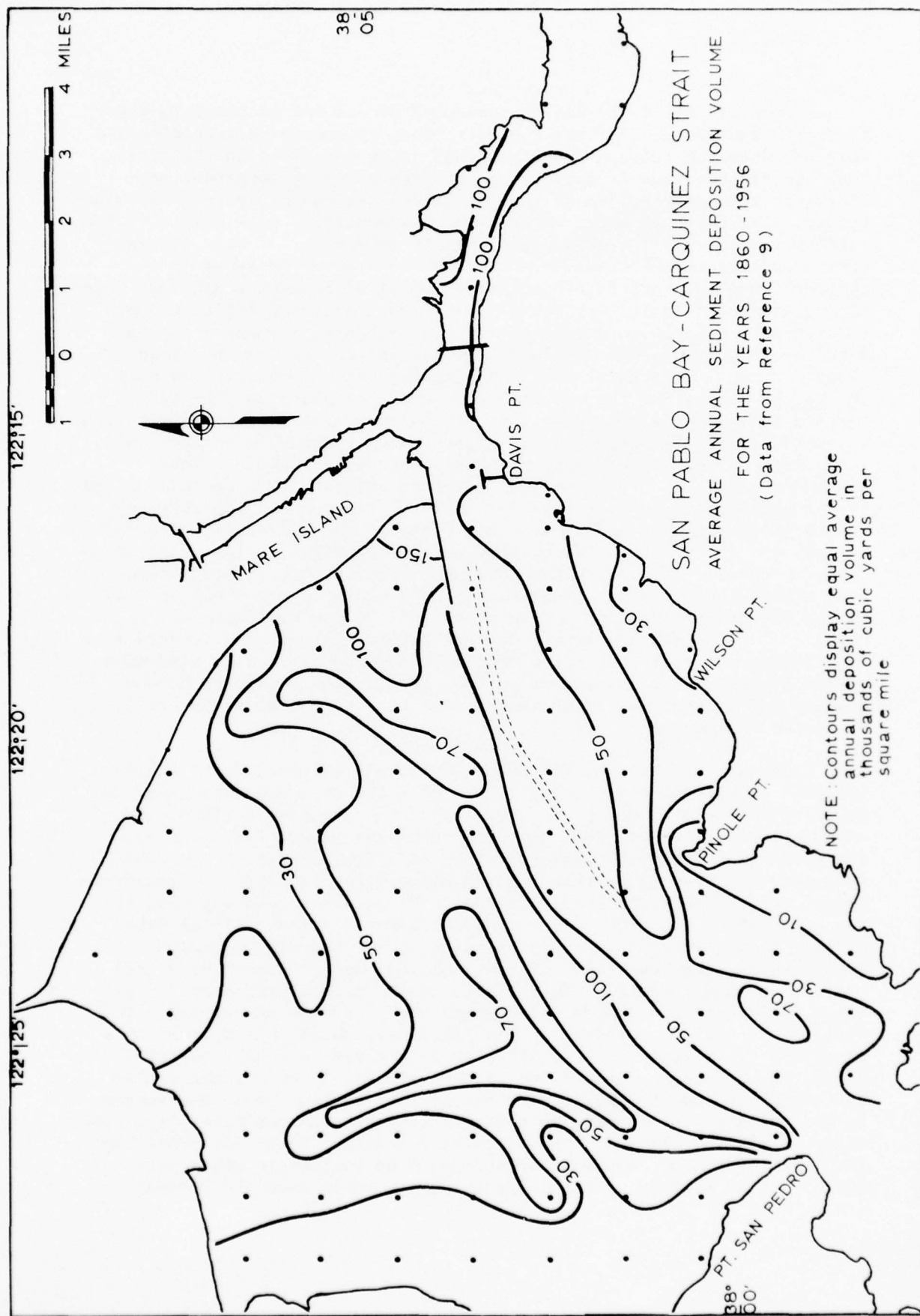
Carquinez Strait and Mare Island Strait are well-mixed for low and intermediate river discharges, but portions may range from partly-mixed to nearly freshwater throughout during periods of large runoff.

Prevailing westerly winds occur in the San Pablo Bay area during much of the spring and throughout the summer. Hills near the western shore of the Bay shelter the adjacent shallow water from the full effect of prevailing westerlies. The long fetch for westerly winds allows sizable waves up to five feet in height to occur over the extensive shallow area in the northeastern portion of the bay. Large waves also occur along the channel, often entering San Pablo Bay from San Pablo Strait. These waves move eastward into adjacent shallow areas.

Most sediment entering the San Pablo Bay area originates from the Great Basin and is conveyed to San Francisco Bay by the Sacramento-San Joaquin River system. These sediments, like the majority of those in the Bay, are principally clay and silt. About 40-60 percent are clays and the remainder are almost entirely silts. Volatile solids are 5-10 percent. Seasonal variations in particle size distribution of surface sediments indicate that much of the sediment deposited in San Pablo Bay cannot be regarded as permanently placed. The estuary's dynamic behavior causes an almost continuous redistribution of sediments after initial deposition. Suspended and bedload sediments are brought into San Pablo Bay during the season of high freshwater runoff, where, initially, the processes of transportation, flocculation, and sedimentation allow an extensive distribution of new deposits. Thereafter, the processes of resuspension, transportation and redeposition alter the pattern of sediment distribution in San Pablo Bay. Tidal action, water circulation, internal shear from mixing and wind-wave action are the principal forces responsible for the distribution of these sediments.

The historical sedimentation pattern in San Pablo Bay and Carquinez Strait has been described by Smith (9). Figure 4 is a contour map of the average annual sediment deposition volume for the years 1860 to 1956, developed from Smith's data. Historically, the channel margins have shown the highest rates of deposition. The shallow areas lying mostly in the northern and western limits of the Bay, with small areas contiguous to the southern shoreline, have had fairly high deposition rates; however, these rates are only about half that of the channel area margins. The channel areas have shown consistent scour.

Carquinez Strait, like channel and intermediate depth areas in San Pablo Bay, has historically experienced very heavy sedimentation along the shoreline, especially the north shore, accompanied by compensating scour in the channel area.



Krone (12) has described the seasonal deposition patterns in the San Pablo Bay area. The high concentrations of suspended particles and internal shearing between fresh and salt water interface in the mixing zone during storm runoff promote rapid aggregation of suspended particles in the water column as they move into San Pablo Bay from Carquinez Strait. The tranquil water circulation regimen shown on Figure 3 in the northern shallows allow these particles to settle to the bed. During spring and summer months daily onshore breezes generate waves in the northern shallows that resuspend newly deposited sediments and keep them in suspension, which allows low velocity tidal and wind drift currents to transport them to more tranquil areas. Material suspended in the large shallow expanse of San Pablo Bay is carried upstream by flood tides. Since the material is already aggregated, concentrations near the bed are high, and the net upstream water movement near the bed carries this material eastward where turbulence mixes it upward with the westward flowing fresh water. This phenomenon results in an increased suspended sediment concentration in the upper water column. These suspended particles are then able to return downstream to be redeposited in the shallow areas where they may again be resuspended, or they may remain in suspension, moving to other parts of the Bay system or out to sea through the Golden Gate, or they may be deposited in low energy areas to form shoals. To confirm this sediment circulation pattern, Krone also studied the physical properties of sediments in the shallows (10). During the short winter period when most of the new sediments are deposited in the shallow areas, the bed surface is composed of very fine uncompacted material. When the shallow areas are exposed to wind-wave action during the spring-summer period, the surface sediments become coarser and a crust is formed that armors the bed and prevents erosion of deeper sediments.

Klingeman and Kaufman (3) have also investigated seasonal shoaling patterns in San Pablo Bay using levels of sediment-sorbed radionuclides as an indicator of deposition. The deposition patterns for suspended sediments entering San Pablo Bay with storm runoff are described by these authors in terms of several zones of differing deposition characteristics. They found that initial deposition of sediments from storm runoff occurs along the dredged channel (Pinole Shoal channel) and on the north and south side of the dredged channel. After initial deposition, an almost continuous interchange occurs between suspended and deposited sediment over much of San Pablo Bay due to wind-wave action in the spring-summer period. The effectiveness of this mechanism diminishes with increasing depth and depends upon location and exposure to waves. The shallow portions of San Pablo Bay, which appear to be in a long-term quasi-equilibrium state with only a very gradual loss of depth, go through a short period of bed aggradation during the winter and a long period of less intense bed erosion during the spring-summer. In the northern shallow region sediment resuspension can take place soon after initial deposition. This area is a sediment reservoir providing long-term supply of sediment for secondary deposition in other parts of the estuarine system, particularly in deeper water near the channel.

The second zone, typified by the southern shallows east of Pinole Point, is also subject to resuspension losses of initial deposits by wind-wave agitation. However, a greater degree of protection against wind-wave resuspension is provided by the shoreline and by the orientation of this area with respect to the direction of strong prevailing winds. Consequently, secondary deposition of sediment removed from the northern shallows may be large in this southern shoal region under suitable conditions. The shallow areas along the western and southwestern shore of San Pablo Bay are probably intermediate in their deposition behavior between that of the northern and southern shallows. Secondary deposition of sediment from the northern shallows is likely because of the pattern of current circulation and waves traveling into the bay from San Pablo Strait.

#### MARE ISLAND STRAIT DREDGING PROJECT

Mare Island Naval Shipyard was established in 1854. The first of a series of navigation improvements in Mare Island Strait was begun by the Department of the Navy in 1892. Subsequent improvements were undertaken by the Corps under the Rivers and Harbors Acts of 13 June 1902, 27 February 1911, and 8 August 1917. The Act of 21 January 1927 increased the channel width to 600 feet and the depth to 30 feet and authorized the Carquinez Strait site as the disposal area. The most recent Act of 2 March 1945 authorized approach areas at Vallejo, South Vallejo and Navy yard piers.

The existing authorized dimensions include: a channel 700 feet wide through Mare Island Strait, flaring to a turning basin generally 1,000 feet wide from former Dike No. 6 to within 75 feet southerly from the causeway between Vallejo and Mare Island, 30 feet deep except at the northerly end where the project depth is 26 feet; two approach areas, 20 feet deep, to the waterfronts at Vallejo and South Vallejo; and maintenance of two approach areas to Navy yard piers at the southern end of Mare Island. The approach areas to the two Navy yard piers are no longer dredged, as these piers no longer exist. Similarly, the approach areas at Vallejo and South Vallejo have not been dredged in recent years. The Mare Island Channel is primarily used by nuclear submarines and other deep-draft Navy vessels moving to and from the Mare Island Naval Shipyard, where maintenance and repair facilities are located.

Mare Island Strait channel has experienced extremely high rates of shoaling, requiring a large amount of maintenance dredging to maintain the channel to a project depth of 32 feet. The average annual quantity of dredged sediment since about 1940 is approximately 2.5 million cubic yards. The high cost of maintaining the channel has resulted in many studies of the shoaling problem. Krone (10, 12) has conducted extensive studies in Mare Island Strait. He reported that even though most sediment is brought into the San Pablo Bay area during storm runoff, the principal

shoaling period in Mare Island Strait is during the spring and summer months when the tidal flood currents bring the resuspended sediments from San Pablo Bay back into Carquinez Strait. The tidal phase lag and bottom flood predominance in Mare Island Strait allows high sediment-laden water to enter the strait and subsequently be trapped due to the surface ebb predominance (2).

The presently authorized disposal site for sediments dredged from Mare Island Strait is at the entrance to Carquinez Strait on the north side of the natural channel.

Dredging operations are conducted in Mare Island Strait in both fall and late winter to maintain the required channel depths. The dredging is accomplished by the Corps' trailing suction hopper dredge, CHESTER HARDING. Each dredging cycle runs about six weeks. During this period the dredge works 24 hours a day, with twelve days on station and two days off. The dredging cycle, including dredging, transit, and disposal, averages about 75 minutes. The Navy maintains its slips with a hydraulic cutterhead dredge with land disposal on the west side of the island.

The quantity of sediments dredged annually from the Mare Island channel by the Corps and the Navy approximates 3.0 million cubic yards, of which approximately 500,000 cubic yards are dredged by the Navy. The dredging of Mare Island Strait represents about a quarter of all maintenance dredging in the Bay-Delta system. A more complete description of the dredging history of the Mare Island channel can be found in Reference 13.

The sediments dredged in Mare Island Strait consist of approximately 60 percent (by weight) clay size particles; 30 percent silt size, and 10 percent fine sand. Organic matter in the sediments includes land erosion debris and some peat material from Delta erosion.

The sources of sediment in Mare Island Strait include flood-borne sediments of the Napa River, suspended sediments from the Sacramento-San Joaquin River System entering the Strait thru Carquinez Strait, resuspended sediments from San Pablo Bay, and dredged sediments returning to the Strait after disposal at the Carquinez site.

Fine sediments enter the Bay as suspended material in tributary streams. Large amounts enter during runoff conditions, and the quantity decreases rapidly thereafter. About 80 percent of sediments entering the Bay are derived from Central Valley drainage through Suisun Bay and Carquinez Strait (2).

The rate of sedimentation in Mare Island Strait during the falling river discharge of spring and summer is less than during the higher river discharge and storms of late winter, based on dredging records and the established pattern of dredging, which is dictated by the rate of

shoaling. The Strait is normally dredged in the late fall (October-November) and later in winter (February-March). The rate of shoaling, derived from Corps dredging records, is greater between the fall-winter dredging than the winter-fall cycle. Table 2 shows the quantities of sediments dredged from Mare Island Strait by the Corps from 1953 to 1977. This data shows that the dredging cycle in the Strait and the dredging quantities vary from year to year, and that variations in sediment inflow and the other dynamic sedimentation processes have a significant effect on the rate of shoaling in the Strait.

The very low quantity of dredged material shown in October-November 1976 and the Spring of 1977 are coincidental with the driest year in recorded history in California.

#### SEDIMENT TRACER PROGRAM

##### INTRODUCTION

The movement of dredged sediment released at the Carquinez site has been studied using the San Francisco Bay hydraulic model (2). The tests used gilsonite to simulate the dredged sediment. The model, however, only allows the study of the deposition and circulation effects of tides and freshwater inflow. The problem of scaling with gilsonite and the lack of resuspension properties, such as wind-wave action, observed in the prototype, place major limitations on the results of these studies.

Krone (15) conducted radioactive tracer studies, using gold ( $^{198}\text{Au}$ ), at the entrance to Mare Island Strait in the early 1960's. The purpose of the tests was to evaluate the efficiency of disposal in Carquinez Strait. Due to the short half-life of  $^{198}\text{Au}$ , the results of the tests were limited in terms of days and the unknowns of dispersion and mixing prevented accurate quantification of the results.

Radioactive tracer studies have also been conducted with sand along the coast of Germany using scandium. Detection was achieved up to 6 to 9 months and quantification of the results was claimed (16). Other field methods of tracing sediment movements in an aqueous environment include the use of fluorescent compounds, mineral compositions, glass beads, and foreign trace element levels. The changes of in situ density, the small particle size range, and the sediment mixing, layering and resuspension in the Bay prevented consideration of previously used methods for this study.

A new technique for following the circulation of sediments had been proposed to the San Francisco District by the Explosive Excavation Research Laboratory (EERL), now the Explosive Effects Division of the Weapon Effects Laboratory of the Waterways Experiment Station. The technique consists of tagging Bay sediments with a trace element in a known abundance. Sediments are sampled at selected locations in the study area and analyzed for the trace element using neutron activation methods. EERL had developed a similar technique for tracing material emplaced in an underground explosive charge and subsequently released to the atmosphere by detonation of the explosive.

TABLE 2

Volume of Material Dredged by the  
Corps of Engineers from Mare Island Strait  
By Dredging Cycle, 1953 - 1977

<u>Dredging Cycle</u>	<u>Volume, yd<sup>3</sup></u>
1 Jul - 31 Aug 1953	535,062
20 Jan - 24 Feb 1954	574,547
12 Apr - 12 May 1954	477,153
1 Nov - 5 Dec 1954	324,348
1 Feb - 15 Apr 1955	1,061,725
31 Aug - 15 Oct 1955	713,200
4 Mar - 14 Apr 1956	618,635
15 Oct 1956 - 14 Apr 1957	1,864,880
1 Oct - 6 Dec 1957	1,150,000
12 Jan - 23 Mar 1959	1,690,000
26 Mar - 25 Apr 1959	229,600
7 Nov 1959 - 21 May 1960	3,629,000
6 Sep - 30 Oct 1960	1,016,000
23 May - 4 Jul 1961	838,000
1-31 Oct 1961 & 1-12 Jan 1962	822,500
22 May - 3 Jun 1962	231,500
1-10 Aug & 11 Sept - 30 Oct 1962	1,643,000
17 Mar - 30 Apr 1963	1,494,500
30 Jul - 23 Sep 1963	1,049,000
15 Mar - 21 Apr 1964	924,900
2 - 4 Aug 1964	129,000
3 - 18 Nov 1964	414,000
15 Mar - 29 Apr 1965	1,960,600
5 Jul - 12 Aug 1965	1,544,000
26 Jan - 22 Feb 1966	1,121,840
5 Sep - 25 Oct 1966	1,129,500
14 - 29 Mar 1967	450,100
12 Aug - 16 Sep 1967	779,700
28 Nov - 25 Dec 1967	703,500
20 Apr - 8 May 1968	467,800
9 Oct - 17 Nov 1968	712,500
31 Mar - 26 Apr 1969	996,000
2 Oct - 3 Nov 1969	1,235,000
5 - 17 Feb 1970	507,000
19 Oct - 28 Nov 1970 & 6-9 Jan 1971	746,000
1-7 Mar & 19 Apr - 9 May 1971	1,211,500
1 Oct - 23 Nov & 15 Dec 1971	1,372,500
13 Mar - 11 Apr 1972	941,500
8 Jan - 23 Feb 1973	1,265,000
26 Oct - 19 Nov 1973	753,000
13 Feb - 2 Apr 1974	1,623,800
20 Sep - 30 Oct 1974	1,255,000
26 Feb - 2 Apr 1975	1,193,000
20 Oct - 26 Nov 1975	1,330,500
19 Feb - 16 Mar 1976	910,000
26 Oct - 7 Nov 1976	252,500
Spring 1977	0

The tracing of sediment movement in the study area was accomplished jointly by EERL and the San Francisco District. The EERL effort, which included contract work by the Stanford Research Institute (SRI), involved developing the technique for the aquatic environment, the introduction of tagged sediments during the February-March 1974 dredging of Mare Island Strait with disposal in Carquinez Strait, and analysis of the samples. The EERL/SRI work included the identification of neutron-activable chemical elements for use as a tracer, selection of an appropriate trace element based on feasibility and cost, development of a sediment tagging procedure, introduction of tagged sediments to the dredged sediments, development of sample analytical methods which would allow quantification of dredged sediment deposition, application of the analytical methods to collected samples from the study area, and documentation of their effort.

The application of the tracing technique involved the fixing of the tracer element onto quantities of Mare Island Strait sediments, introduction of this tagged sediment into the dredge hoppers prior to release at the Carquinez Strait site, sampling bottom sediments throughout the study area for a 10-month period, and quantitative analysis of the collected samples. The San Francisco District was responsible for the type and method of sediment sampling and the collection of samples from the study area. Evaluation of the data was accomplished by the San Francisco District. The research performed by EERL and SRI is reported in Reference 17 and is reproduced in this report as Inclosure 1.

#### THE NEUTRON ACTIVATION TECHNIQUE

Chemical elements, when exposed to thermal neutrons in a nuclear reactor, become radioactive by capturing the neutrons. The radioactive atoms (radionuclides) of the element formed decay by releasing energy in the form of an electron (beta particle) and one or more gamma rays. The period of time required for the radionuclide to lose 50 percent of its activity is known as its "half-life." If the decay process is accompanied by one or more gamma rays, the gamma rays have a characteristic energy level which is associated with the atomic mass and chemical species of the decaying radionuclide. Measuring the gamma-ray energies emitted by an activated sample identifies the neutron-activable elements present. The quantity of each of the elements in the sample can be calculated if the gamma-ray emission rate and neutron exposure of the sample are known.

In using the neutron activation technique to trace sediment movements, a small amount of a trace material in very low abundance in the prototype system (at least a factor of five less than that being added) is fixed to a quantity of sediment and introduced at a known concentration into the dredge hopper. The dredged sediment and the tagged sediment are then released into the study area at the disposal site. After a period of time, bottom sediment samples are taken, processed, neutron activated, and the amount of trace element in the sample determined. Knowing the abundance of trace element fixed to the original sediments and the amount of the tagged sediments added to each hopper load allows the calculation of the percentage of dredged sediment present in a bottom sample.

The selection of a trace element to be used with the Mare Island Strait sediments was based on an extensive investigation of chemical element concentrations in sediments from Mare Island Strait and San Pablo Bay and an evaluation of detection limits based on dispersal of sediment in the entire study area and the quantity of new sediments entering the system. Estimates of total sediment movement over a one-year period within the study area ranged from ten to twenty million cubic yards of sediment, which included the quantity dredged, sediment inflow to the study area, and the mixing of sediments in San Pablo Bay, Mare Island and Carquinez Straits, and Suisun Bay.

After an investigation of numerous candidate trace elements, EERL limited the field to gold, rhenium, and iridium. Gold was eliminated from further consideration due to a high natural abundance and, therefore, higher cost, and rhenium was eliminated based on its short half-life and the interference by other elements in the resolution of the rhenium signal. Iridium was selected for use as the trace element by EERL for the following reasons:

a. "The amount of iridium required minimizes the mass that must be added to the traced sediment and, therefore, would least affect particle settling characteristics."

b. "The limit of detection for iridium is a factor of two lower than that for rhenium."

c. "The 74.37 day half-life permits examination of neutron activated samples at significantly long post-irradiation time without significant reduction in signal due to radioactive decay."

The abundance of iridium determined to occur naturally in the study area is  $5 \times 10^{-10}$  grams of iridium per gram of dry sediment.

#### SEDIMENT TAGGING AND INTRODUCTION TO TEST AREA

The iridium, approximately 22 pounds (9.9 kg), was purchased in the form of a metal powder and subsequently converted to a soluble iridium salt. The soluble salt was then surface adsorbed to 21,729 pounds ( $9.86 \times 10^6$  grams) of sediment previously dredged from Mare Island Strait by the Navy and deposited in a land disposal site. The resulting abundance of iridium in the tagged sediments was approximately  $1.01 \times 10^{-3}$  gram of iridium per gram of dry sediment.

The chemical and physical properties of the sediment from the land disposal site were investigated and found to be essentially the same as those of sediments taken from dredge hoppers during a previous dredging of Mare Island Strait.

A total of 8,169 gallons ( $30.9\text{m}^3$ ) of tagged sediment in 5-gallon cans and 55-gallon drums was placed aboard the Corps dredge, CHESTER HARDING, in February 1974. The dredge is shown in Figure 5.

The injection of tagged sediments began on 19 February 1974 and continued until 30 March 1974. The dredge worked continuously 24 hours per day for 12 days, followed by a 2-day lag. A total of 706 dredging cycles were made during the 35 dredging days. The dredged area and the disposal site are shown in Figure 6. Tagged sediments were introduced during all tidal conditions.

The volume of sediments carried in the dredge hoppers was calculated during nine cycles. The measurements were taken at the beginning, the middle, and at the end of the dredging period. The data is reported in Appendix C, Water Column. The volume of sediment transported in one cycle is based on analysis of samples of sediment entering the hoppers and vessel displacement. The following describes the sediment values used and the calculation of the total weight and volume of sediments dredged from the Strait during the injection period:

- (1) In-situ volume of 2,300 cubic yards of sediment carried per cycle
- (2) Density of solids and water = 1.3 grams/cubic centimeter (g/cc)
- (3) Density of solids = 2.75 g/cc
- (4) Density of salt water = 1.025 g/cc
- (5) Absolute volume of solids = 15%
- (6) Density of solids:

$$\frac{(2.75 \text{ g/cc})(7.646 \times 10^5 \text{ cc/yd}^3)}{(4.5359 \times 10^2 \text{ g/lb})(2,240 \text{ lb/long ton})} = \underline{2.069 \text{ long tons/yd}^3}$$

- (7) Total dry weight of dredged sediments:

$$(2,300 \text{ yd}^3/\text{load})(0.15)(2.069 \text{ tons/yd}^3)(706 \text{ loads}) = 503,946 \text{ long tons}$$

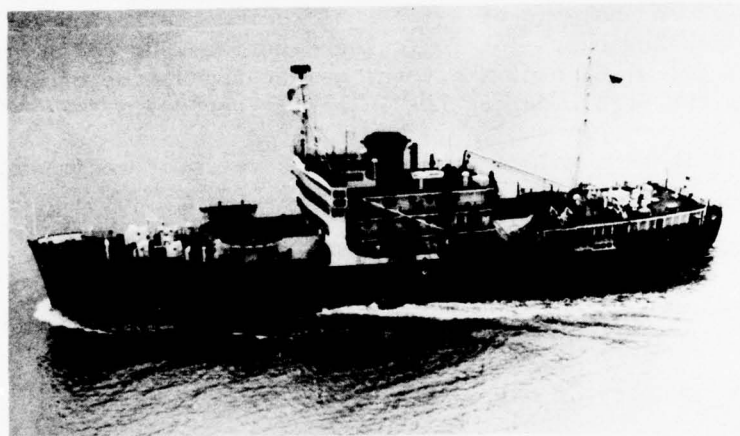
say 504,000 long tons

- (8) Volume of in-situ dredged sediments:

$$(2,300 \text{ yd}^3/\text{load})(706 \text{ loads}) = 1,623,800 \text{ yd}^3$$

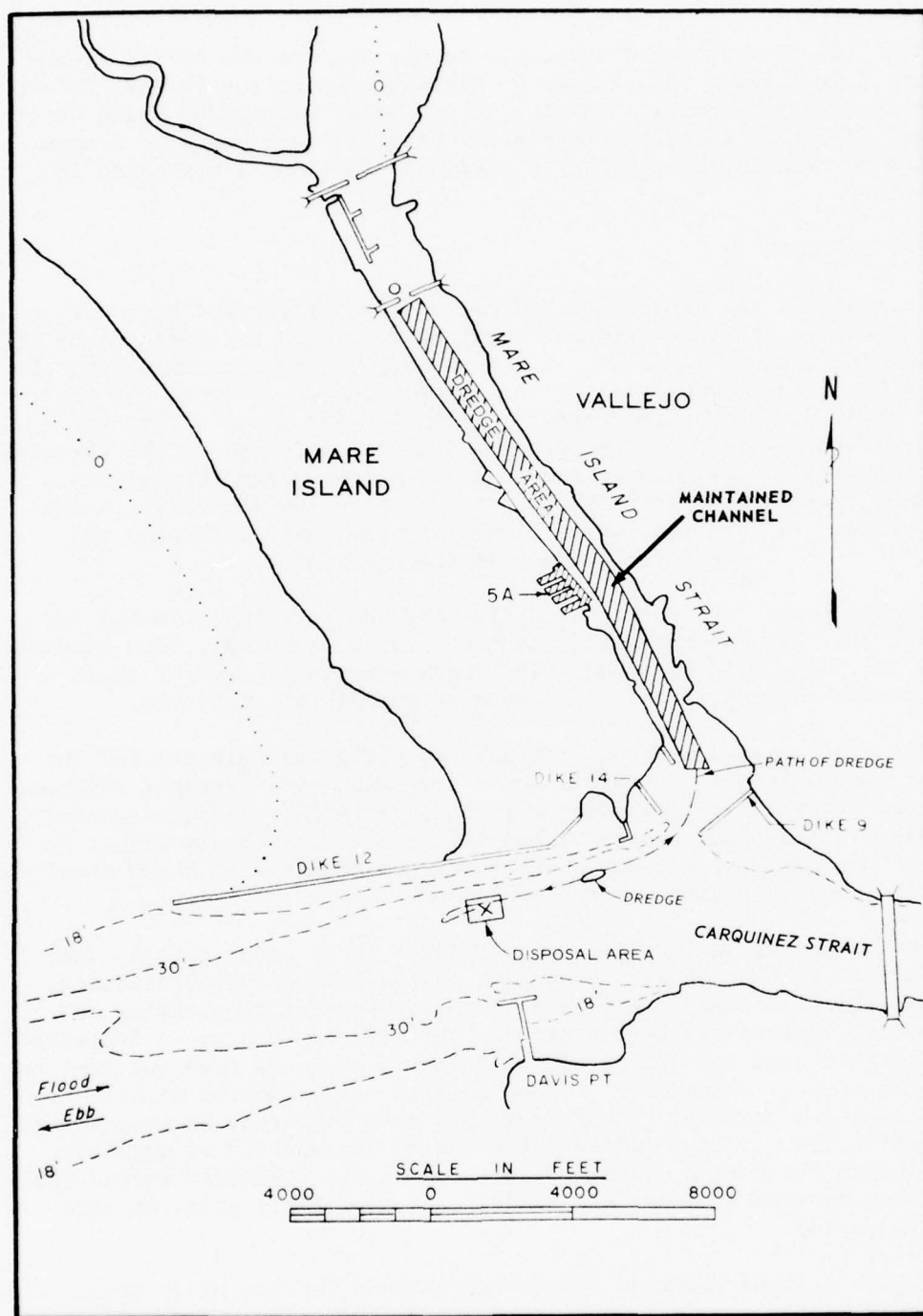
say 1,624,000 yd}^3

Thus, with 9,900 grams of iridium added to the 504,000 long tons ( $5.12 \times 10^{11}$  grams) of dredged sediments, the abundance of iridium in the dredged sediment was  $1.95 \times 10^{-8}$  grams of iridium per gram of dry sediment.



CORPS OF ENGINEERS HOPPER DREDGE  
CHESTER HARDING

FIGURE 5



Area Dredged in Mare Island Strait

FIGURE 6

Addition of the tagged sediments to the hoppers was always accomplished after leaving the channel to avoid contamination of Mare Island Strait by hopper overflow. The tagged sediments were added using water pressure injection through standpipes located in each hopper. A more detailed description of the tagged sediment addition is contained in Inclosure 1.

#### SEDIMENT SAMPLING

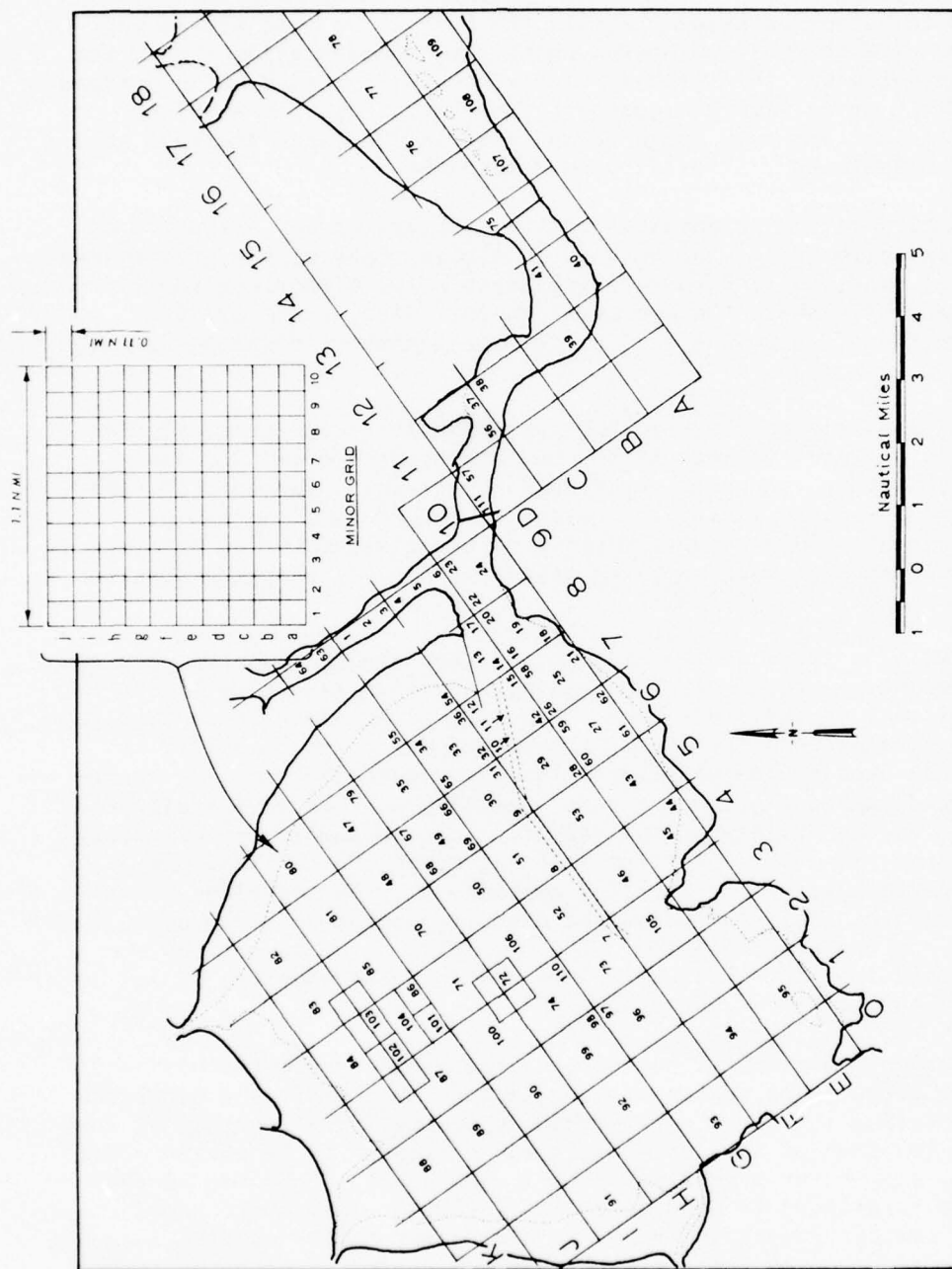
To quantify the deposition and circulation of dredged sediment, a high percentage of tagged sediment must be accounted for during each of the sampling periods. For this reason a sampling area encompassing the maximum limits of circulation of the tagged dredged sediment was desirable. Prior studies by the Corps of Engineers and Krone (2,15) indicated that the majority of the dredged sediment released at the Carquinez Strait disposal site would remain in an area encompassed by San Pablo Bay, Carquinez Strait, Mare Island Strait and Suisun Bay during a one-year period. In addition, special samples were taken to expand the interpretation of sediment movement in the study area.

Methodology. A number of sampling methods were investigated for possible use. The investigation included random sampling, bias sampling (fixed station), grid bias and grid random sampling. Each of these methods have advantages and disadvantages associated with them.

The grid sampling method with bias sampling was selected for the tracing program since it would allow a time history of dredged sediment abundance at each sampling station to be calculated. Random sampling provides a statistical approach; however, sampling emphasis cannot be given to any particular area, such as dredged channels or known shoaling areas, for fear the data may become biased.

The grid size is very important because it is assumed that each grid is uniform throughout. Depending on the bottom characteristics, the uniformity assumption may lead to faulty results when trying to interpolate between sampling stations. Hence, care was taken in selecting the grid size and orientation. However, emphasis does not have to be placed on grid uniformity if a more valid assumption of distribution of material can be made. The grid method also permitted an assignment of relative importance to different areas by designation of smaller grids within the larger grids. Bias sampling was conducted within the grids and involved sampling the same location within a grid for each sampling period.

Figure 7 shows the grid system established for the study area. The basic grid system consists of grids 1.1 nautical miles square and is oriented 58 degrees east of north. Each basic grid was further subdivided into a minor grid (shown in Figure 7) with 0.11 nautical mile square grids. Using the grid bias sampling method, grid uniformity is not required. However, to create an actual grid sediment budget for the



Tracer Program Grid

FIGURE 7

study area the grid uniformity assumption is required. The primary factor in determining grid uniformity for the sampling program was uniformity in bottom bathymetry within the grid. The grid system was oriented to give the maximum bottom uniformity to each grid. Where the bottom bathymetry within a grid is highly non-uniform such as in dredged channels,  $X^{1/2}$  grids were designated. Conversely, where the bottom bathymetry is uniform over large areas, such as the large shallows area in north San Pablo Bay,  $X^2$  grids were designated.

The rationale for orientation of the grid system and selection of actual sampling locations can be seen in a comparison of the grid system and sampling stations in Figure 7 with Smith's (9) historical shoaling data in Figure 4. Where the contours are far apart, there are few sampling stations; where contours are closer together, sampling stations are more concentrated.

Thus, planning for the sampling operation included later calculation of grid sediment volumes if the uniformity of dredged sediment distribution within the grids could be demonstrated. However, the primary objective of determining the extent of long-term dispersal of dredged sediments could be determined from the time-histories of dredged sediment abundance at each sampling station since the sampling stations covered the entire study area.

Samples were taken at the midpoint of each designated grid once per sampling period. A total of 111 sampling locations (shown on Figure 7) were established in the study area. Sampling locations were located in the deep waters of Carquinez Strait; however, due to an inability to penetrate the hard bottom at several locations with the sampling equipment, limited sampling was conducted. Sampling periods were designated monthly due to the ability of the sampling boat to sample approximately five locations per day. The first sampling month, March 1974, was divided into two periods by sampling approximately 50 locations twice during the month. This increased the time resolution on sediment transport from the disposal site. The remaining sampling periods occurred monthly from April-December 1974 and included sampling of approximately 100 locations per month.

Collection. Horizontal control for the sampling program was provided by three-point sextant triangulation, and, where the water was shallow, sampling locations were marked by stakes. The accuracy of the horizontal location of sampling points was estimated to be on the order of 50 feet, except for staked locations. The depth of the top of the samples was referenced to mean lower low water datum by staff gages located at various points in the study area close to the sampled locations. The accuracy of the depth control was estimated to be  $\pm 6$  inches. At staked locations depth control was very accurate; however, at unstaked locations, depth estimates were made based on the time the sample was taken during the tidal cycle and a depth control of  $\pm 6$  inches was probably not attained.

The sampling program was conducted using a modified World War II landing craft medium (LCM). The cargo deck of the LCM was modified with a well through the deck and hull. A double "A" frame was positioned above the well for raising and lowering of the sampling equipment through the well. A picture of the sampling boat and the well through the deck and hull are shown in Figure 8.

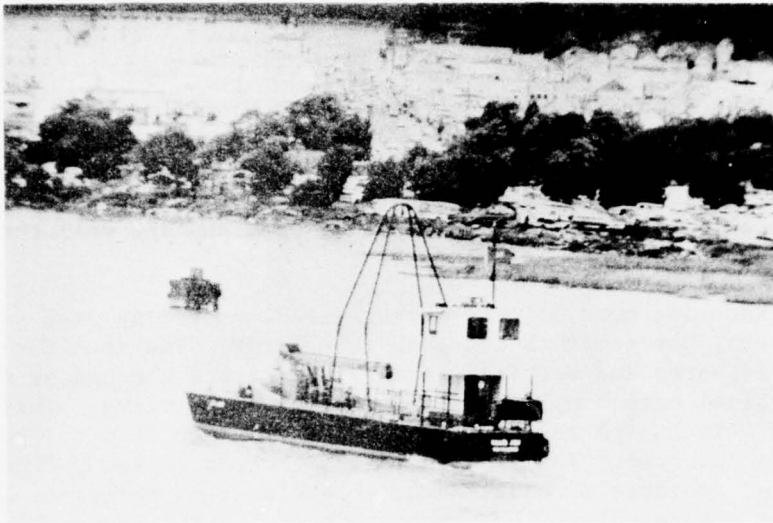
Several sampling methods were investigated, including grab samplers, gravity samplers, box samplers and push tube cores. The need for a specific surface area and vertical integrity dictated the use of the push-tube vertical core sampling method for bottom sampling. This method uses a 4-inch pipe casing in which a 2-1/8-inch ID steel push-tube barrel is inserted. The pipe casing is lowered to the bottom from the surface and provides a readily available elevation reference and reentry into the same hole. The push-tube barrel with acrylic liner is then inserted into the pipe casing and pushed into the sediment to obtain a core sample. Core samples up to 30 inches in length could be taken; however, 20-inch samples were normally taken to insure inclusion of the top layer of sediment. Five core samples were normally taken at each sampling location. Each sample was logged and labeled and stored for subsequent processing. The nomenclature used to describe the sediments in each core log was:

- a. "Fluff" - very fine particles suspended in the top layer of the sample.
- b. "Active" - most recently deposited sediments believed to be easily resuspended by wave and/or current action.
- c. "Inactive" - sediments believed to move rarely, if ever.

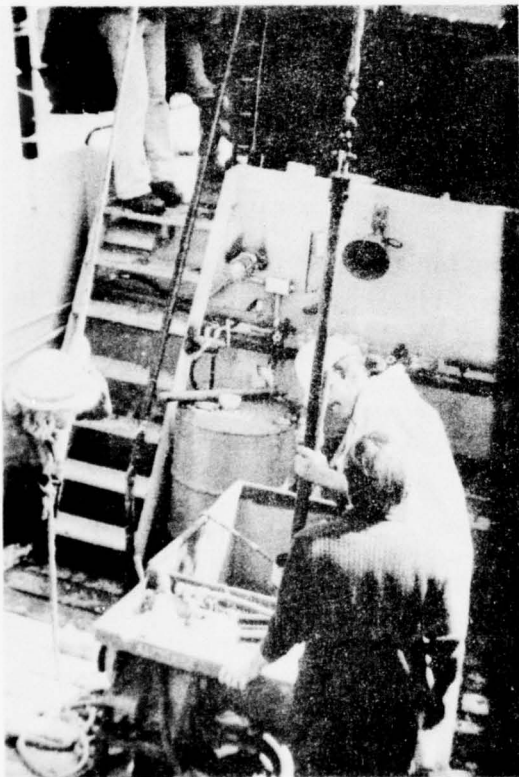
A sample log and description of the labeling process is described in Inclosure 1. A picture of various samples in the acrylic tube liners is shown in Figure 9.

Processing. The daily collection of samples was taken from the sampling boat and stored at Mare Island Shipyard for subsequent shipment to the SRI (under contract to EERL) processing area at Camp Parks, near Dublin, CA.

Prior to commencing sampling operations, there was general agreement among consultants and literature that the dispersed dredged sediment would be concentrated in the top 1 inch of sampled sediments. To obtain a sufficient volume of sediment for processing the top 1 inch, five samples were taken at each station. Subsequent sample increments were processed at four-inch intervals, based on a minimum of sediment for processing. Nine inches was selected as the depth of processing to include all dredged sediments, and certain samples were processed to greater depths to insure accuracy of the mixing theory.

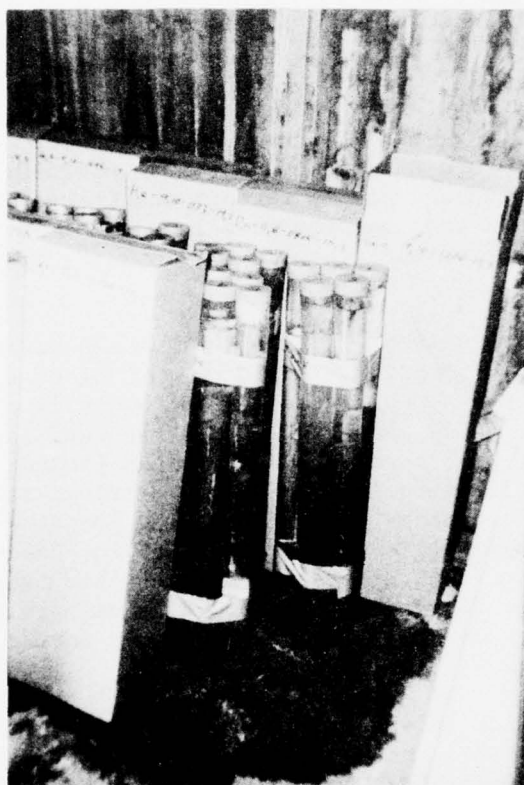


LCM sampling boat



Well through the deck and  
hull of the LCM to accommodate  
raising and lowering of  
sampling equipment

FIGURE 8



Sampled bottom sediments in acrylic tubes.

FIGURE 9

The top one inch of sediment from each of the five tubes from a particular location was removed, dried, and the weight of dry sediment recorded. The remaining sediments in one of the five tubes was then selected for further processing, and the sediments were carefully removed in 4-inch increments. Each of these 4-inch increments was also dried and the weight recorded. The remaining four tubes were stored for possible future use.

The five 1-inch increments were combined into one sample and ground and passed through a 20-mesh sieve. These increments were combined to produce a sample large enough to extract a 50-gram aliquot. The 4-inch increments were also ground and passed through the mesh. For identification purposes, the top 1-inch samples were labeled as layer "A" and the subsequent 4-inch samples were labeled layers "B," "C," "D," "E," etc.

A 50-gram aliquot was selected from each incremental layer for determination of iridium content. The iridium content of each aliquot was determined using a fire assay process. Fire assay is a process used in the assay of ores for noble metals. In this process, finely divided ore is mixed with lead oxide, a reducing agent, and fluxing materials. The mixture is heated until it melts, and, upon melting, separates into two liquid phases. The ore stays on top in a slag phase, and the noble metals and a few other elements in the heavy metallic phase on the bottom. When the mixture cools, the slag and the noble metals are separated and the slag is discarded. The noble metals are then formed into a right cylinder and sealed in an aluminum tube for neutron activation.

The irradiation of the encapsulated metals was performed at the General Atomic TRIGA Mark III reactor at the University of California, Berkeley. After an adequate decay period, the irradiated samples were taken to SRI's Camp Parks facility for gamma ray counting and determination of iridium content. The sample processing, irradiation, and iridium content determination is explained in greater detail in Inclosure 1.

With the weight of iridium in a sample known, the grams of iridium per gram of dry sediments (g Ir/g),  $S_{Ir}$ , was determined and the percentage of dredged material in a sample was calculated as follows:

$$\text{percent dredged material} = \frac{S_{Ir} - B_{kg}}{D_c} \times 100 \quad (1)$$

where:

$B_{kg}$  = naturally occurring iridium in study area sediments plus  
iridium in fire assay chemicals =  $3.16 \times 10^{-10}$  g Ir/g

$D_c$  = abundance of iridium in the released dredged sediments  
=  $1.95 \times 10^{-8}$  g Ir/g

Sir and percent dredged material was calculated for each sample increment for all sampled locations. The numerical results of sample processing for the 111 sampling locations in the study area by sampling period is displayed in Inclosure 2 and the results for stations 53 and 71 are shown in Figure 10. In the data sheets the first two lines give the coordinates of the sample, the hole number, and the general area of the sampled hole. The third line gives the date the samples were taken and the fourth line lists the depth of the top of sediments below MLLW in feet. The next three lines give the thickness in inches of the fluff, active, and inactive layers, as recorded on the core log sheets.

The remaining information on the data sheets pertains to particular samples and increments of each sample. Sample A represents data from the combination of the top one inch of sediments from all five cores taken at a particular location on one date. The remaining sample names, B, C, D, etc., represent data from subsequent 4-inch increments of sediments from one of the five cores. The number opposite Sample A, Sample B, etc., is the capsule number assigned to the aluminum container which was irradiated. The data in Inclosure 2 shows that only layers A, B, and C were consistently processed and deeper layers processed intermittently.

As discussed earlier, the percentage dredged material displayed for each sample in Inclosure 2 was derived by dividing the measured iridium abundance in the sample (less the background) by the theoretical iridium abundance in the dredged sediments, assuming that the iridium was uniformly fixed to the tagged sediments and the tagged sediments were uniformly mixed in each hopper.

Several values of percent dredged material in the initial sampling periods were greater than 100 percent. This resulted from either non-uniform mixing of the tagged sediments with the dredged sediments and/or from the rehandling of previously dredged sediments (returning to the Strait) in the hoppers.

Special Samples. In addition to the samples taken at regular intervals in the study area, other sediment samples were taken in an attempt to further define the dredged sediment circulation. These additional samples were taken from the hoppers of the dredge during the February-March 1974 and October-November 1975 dredging cycles, from selected shoaling areas in Central and South Bays indicated on Figure 11, and from 10 cross sections of Mare Island Strait shown on Figure 12.

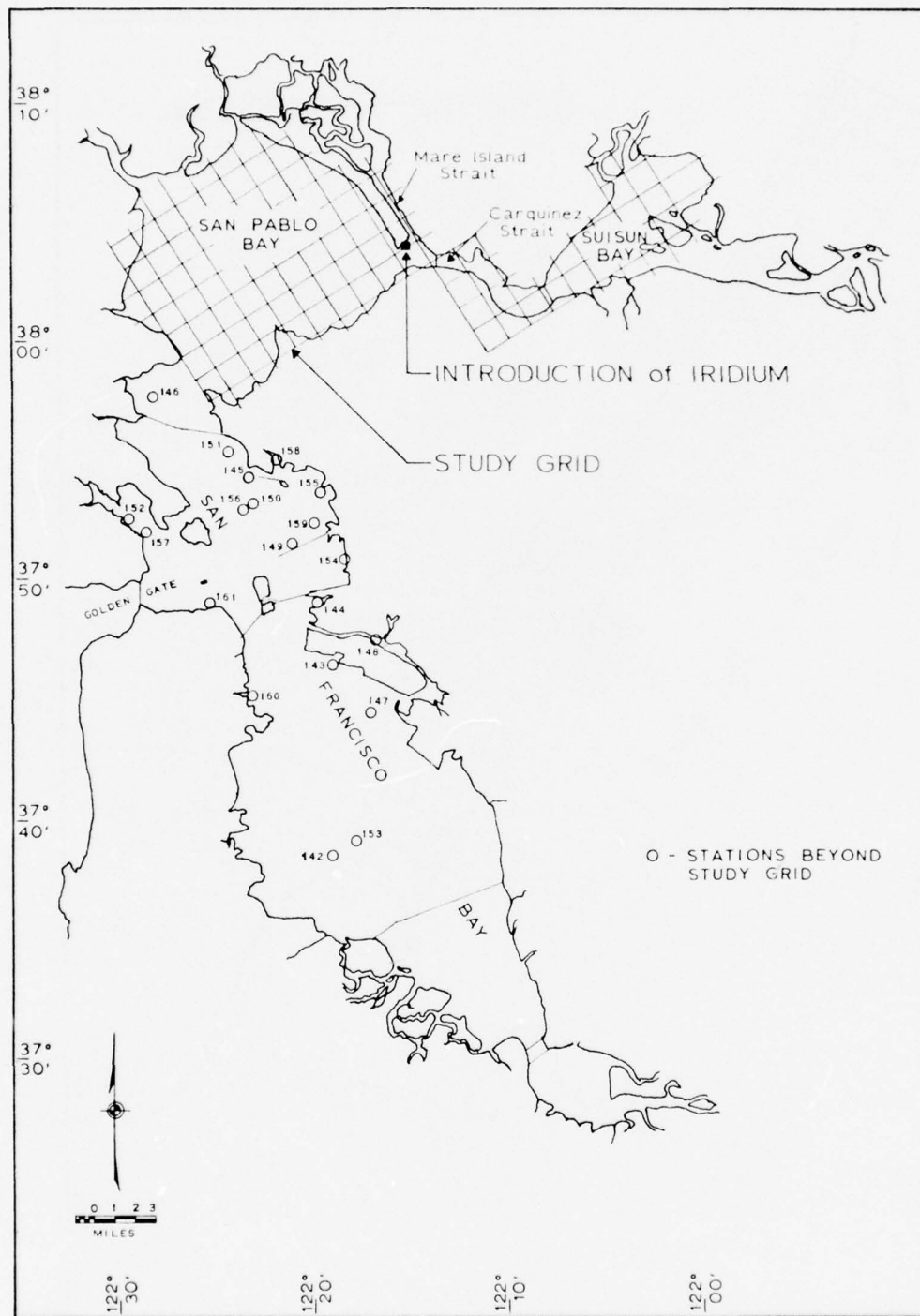
The purpose of taking hopper samples was to determine if the dredge was rehandling previously dredged sediment and to estimate the return of tagged sediments to the dredged channel. The hopper samples taken during the February-March 1974 dredging were collected on every tenth

COORDINATES	HOLE NO	LOCATION							
E H 6 B	59	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES	2APR74	2MAY74	4JUN74	9JUL74	2AUG74	3SEP74	17OCT74	5NOV74	13DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)	10.0	8.5	8.5	8.0	9.0	7.5	8.5	9.0	8.5
THICKNESS OF LAYERS (IN)									
FLUFF	0.4	1.5	1.5	2.0	3.0	0.0	2.0	0.0	2.0
ACTIVE	20.0	8.0	6.0	5.0	6.0	5.0	7.0	5.0	6.0
INACTIVE	0.0	6.0	12.0	11.0	15.0	9.0	14.0	12.0	17.0
SAMPLE A	3922	1297	1603	1894	2203	2476	3022	3103	3364
G DRY/CC WET MUD	0.674	0.697	0.746	0.687	0.696	0.836	0.659	0.549	0.494
G IR/G DRY MUD	5.31E-11	1.61E-10	2.39E-10	3.96E-10	1.53E-10	2.68E-10	5.49E-10	2.00E-10	2.80E-10
% DREDGE MATERIAL	0.000	0.000	0.000	0.412	0.000	0.000	1.193	0.000	0.000
SAMPLE B	3923	1298	1604	1895	2204	2477	3023	3104	3365
G DRY/CC WET MUD	0.382	0.666	0.500	0.524	0.630	0.692	0.564	0.790	0.493
G IR/G DRY MUD	-BOL-	2.95E-10	2.67E-10	4.95E-10	2.92E-11	1.09E-10	1.08E-08	2.71E-10	3.03E-10
% DREDGE MATERIAL	0.000	0.000	0.000	0.919	0.000	0.000	53.623	0.000	0.000
SAMPLE C	3924	1299	1605	1896	2205	2478	3024	3105	3366
G DRY/CC WET MUD	0.474	0.529	0.516	0.628	0.513	0.670	0.553	0.784	0.590
G IR/G DRY MUD	4.83E-10	4.48E-10	9.21E-10	4.72E-10	3.74E-10	1.59E-10	8.50E-10	8.7E-10	1.92E-09
% DREDGE MATERIAL	0.854	0.677	3.103	0.803	0.298	0.000	2.739	0.000	8.224
SAMPLE D		4404	4642	4406					4783
G DRY/CC WET MUD		0.584	0.711	0.569					0.647
G IR/G DRY MUD		-BOL-	2.54E-10	1.24E-10					1.32E-10
% DREDGE MATERIAL		0.000	0.000	0.000					0.000
SAMPLE E		4405	4643	4407					
G DRY/CC WET MUD		0.495	0.617	0.706					
G IR/G DRY MUD		2.28E-10	4.99E-10	4.28E-10					
% DREDGE MATERIAL		0.000	0.941	0.576					
SAMPLE F									4784
G DRY/CC WET MUD									0.634
G IR/G DRY MUD									4.40E-10
% DREDGE MATERIAL									0.638
SAMPLE G									
G DRY/CC WET MUD									
G IR/G DRY MUD									
% DREDGE MATERIAL									
SAMPLE H									
G DRY/CC WET MUD									
G IR/G DRY MUD									
% DREDGE MATERIAL									

COORDINATES	HOLE NO.	LOCATION							
I E 4 5	71	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES	12APR74	10MAY74	7JUN74	22JUL74	6AUG74	5SEP74	16OCT74	23NOV74	17DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)	7.5	6.0	6.5	6.5	7.0	6.5	6.5	7.0	7.0
THICKNESS OF LAYERS (IN)									
FLUFF	1.0	1.0	2.0	0.0	0.5	0.0	2.0	0.0	1.0
ACTIVE	10.0	8.0	16.0	3.0	14.0	8.0	6.0	2.0	4.0
INACTIVE	11.0	12.0	5.0	9.0	3.0	3.0	9.0	20.0	12.0
SAMPLE A	1147	1417	1663	2020	2230	2560	2986	3262	3613
G DRY/CC WET MUD	0.391	0.635	0.629	0.560	0.580	0.805	0.530	0.507	0.613
G IR/G DRY MUD	7.25E-10	5.14E-10	2.38E-10	3.10E-10	2.74E-10	3.77E-10	6.13E-10	4.63E-11	9.94E-10
% DREDGE MATERIAL	2.097	1.013	0.000	0.000	0.000	0.310	1.525	0.000	3.476
SAMPLE B	1148	1418	1664	2021	2231	2561	2987	3263	3614
G DRY/CC WET MUD	0.587	0.567	0.583	0.537	0.658	0.678	0.562	0.600	0.626
G IR/G DRY MUD	7.69E-10	1.05E-09	2.15E-10	2.42E-10	1.05E-10	8.24E-10	5.67E-10	1.35E-10	2.36E-10
% DREDGE MATERIAL	2.321	3.785	0.000	0.000	0.000	2.604	1.287	0.000	0.000
SAMPLE C	1149	1419	1665	2022	2232	2562	2988	3264	3615
G DRY/CC WET MUD	0.527	0.643	0.524	0.609	0.657	0.720	0.660	0.702	0.636
G IR/G DRY MUD	5.15E-10	5.90E-10	8.69E-10	1.50E-10	-BOL-	3.33E-10	-BOL-	3.77E-10	4.70E-10
% DREDGE MATERIAL	1.021	1.406	2.836	0.000	0.000	0.088	0.000	0.313	0.788
SAMPLE D			4454		4455	4457	4458	4837	4839
G DRY/CC WET MUD			0.679		0.824	0.875	0.699	0.602	0.568
G IR/G DRY MUD			5.45E-10		6.01E-10	-BOL-	-BOL-	0.00E+00	1.67E-10
% DREDGE MATERIAL			1.175		1.461	0.000	0.000	0.000	0.000
SAMPLE E					4456		4459		4840
G DRY/CC WET MUD					0.811		0.718		0.589
G IR/G DRY MUD					4.10E-10		-BOL-		3.63E-10
% DREDGE MATERIAL					0.482		0.000		0.242
SAMPLE F									4838
G DRY/CC WET MUD									0.573
G IR/G DRY MUD									-BOL-
% DREDGE MATERIAL									0.000
SAMPLE G									
G DRY/CC WET MUD									
G IR/G DRY MUD									
% DREDGE MATERIAL									
SAMPLE H									
G DRY/CC WET MUD									
G IR/G DRY MUD									
% DREDGE MATERIAL									

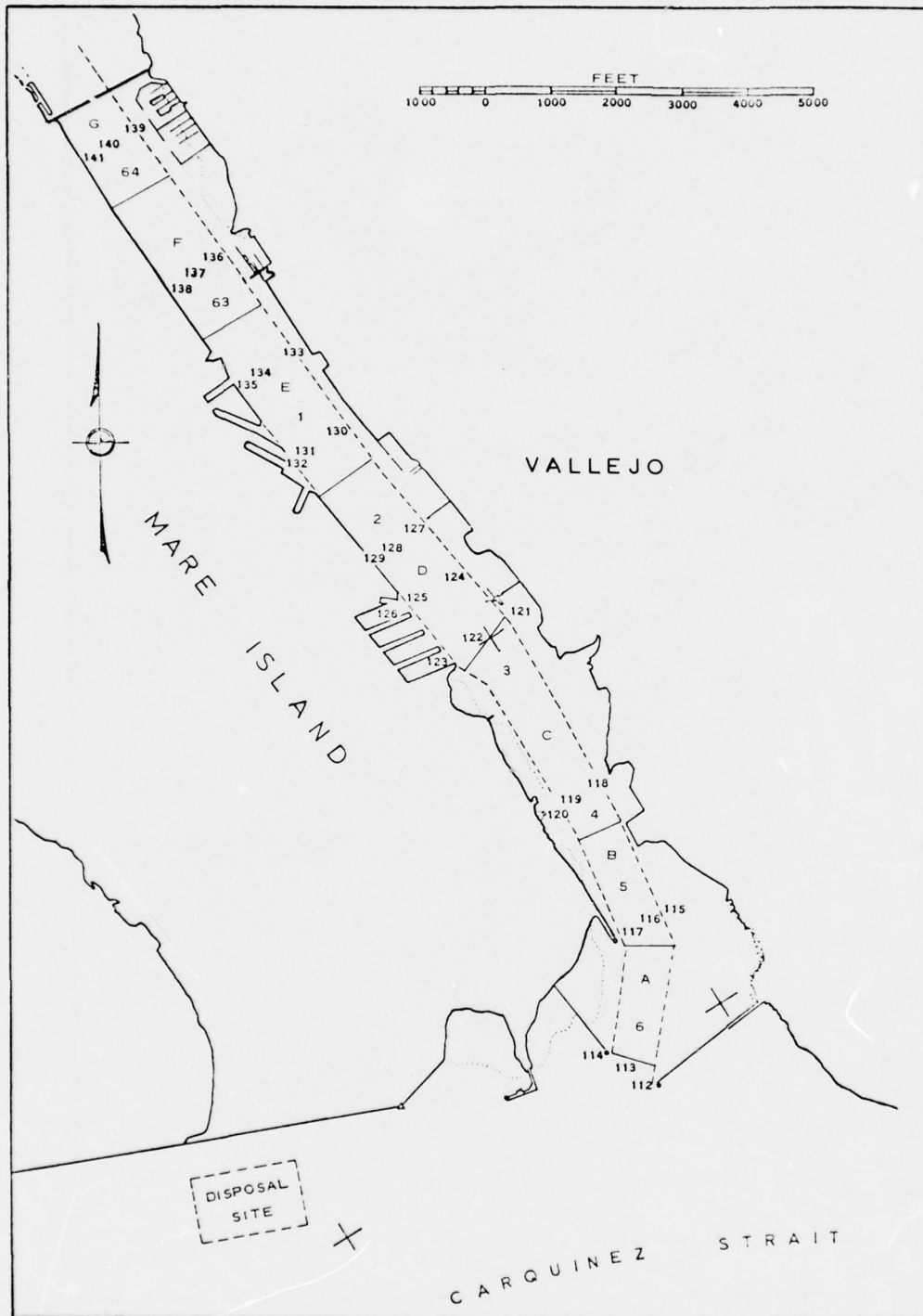
Data sheets for holes 59 and 71, San Pablo Bay F

Data sheets for holes 59 and 71, San Pablo Bay Flats



Sampled Locations in Central and South Bays

FIGURE 11



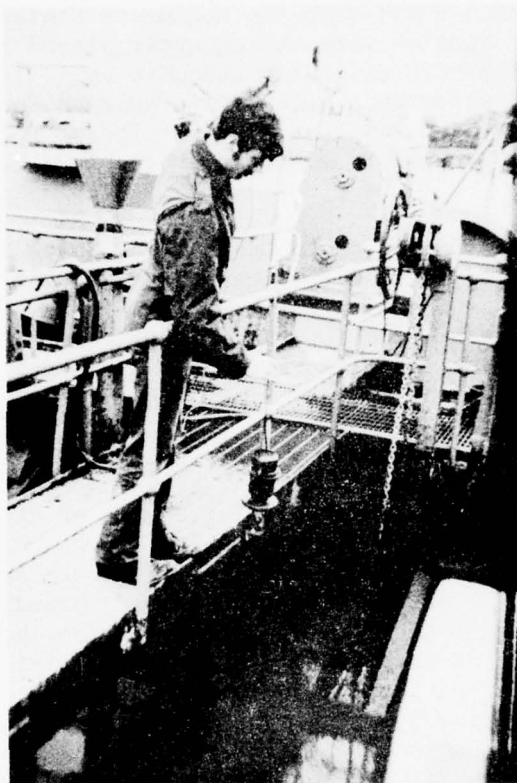
Mare Island Strait Cross Section Stations and Channel Sections

FIGURE 12

dredging cycle and prior to the introduction of iridium into the hoppers. The samples were taken by dipping a plastic container into the sediments in the hopper. A picture of the hopper sampling operation is shown in Figure 13. The samples taken on 30 October 1975 were taken by lowering a bucket into the hopper and sampling sediments coming into the hopper via the chute. The samples were subsequently placed in plastic containers. All samples were carefully taken to avoid iridium contamination. All hopper samples were dried, fire assayed, and processed similar to the study area samples. The results of the hopper sampling in February-March 1974 are presented in Inclosure 2 and on 30 October 1975 in Table 3.

Sampling of shoaling areas in Central and South Bays was to determine if the dredged sediments released in Carquinez Strait contributed significantly to shoaling in these areas. Samples were taken at 20 locations (Figure 11) from September to December 1974. These samples were processed the same as the study area samples and the results are presented in Inclosure 2.

The purpose of sampling along cross sections of Mare Island Strait (Figure 12) was to determine the extent of movement of dredged sediments back into the Strait prior to the fall dredging of the Strait from 20 September - 30 October 1974. In late August 1974, 30 core samples were taken along 10 cross sections of the Strait. These samples were subdivided into two equal sections per tube, homogenized, and a 50-gram aliquot taken from each section for analysis. The length of the sample was 30 inches; hence, each section represented a 15-inch layer of sediments. At most locations only a 30-inch sample was taken. At several locations two successive samples, representing a 60-inch depth of sediments, were taken. The results of analysis of the cross section samples are shown in Inclosure 2. The successive 15-inch sample sections have been identified as layers B, C, D, and E.



Sediment sampling of material in the dredge hoppers prior to introduction of tagged sediments.

FIGURE 13

Table 3

HOPPER SAMPLING RESULTS FROM  
OCTOBER-NOVEMBER 1975 DREDGING

<u>Date</u>	<u>Time</u>	<u>Location (Channel Section<sup>1/</sup>)</u>	<u>Percentage Dredged Material</u>
10/30	AM (1136)	E	1.29
10/30	AM (1143)	E	1.60
10/30	AM (1147)	F	2.69
10/30	PM (1240)	E	6.77
10/30	PM (1246)	D	1.60

<sup>1/</sup> Figure 12 shows the channel sections.

## HYDROLOGIC AND CLIMATIC CONDITIONS

Prior to analysis of the tracer program data, information on freshwater inflow to the study area through Carquinez Strait and wind conditions occurring during the timeframe of the data collection are documented and discussed. Many other environmental factors were no doubt involved in determining the overall circulation of dredged sediments; however, freshwater inflow and wind in addition to tides are generally recognized as important variables in generalizing on sediment deposition, suspension, and circulation.

Figure 14 shows the freshwater inflow through Carquinez Strait for 1974. As seen in the figure, a relatively high flow of approximately 76,000 cfs was experienced during March with a peak flow of 244,000 cfs in April. For the remainder of the sampling periods an average flow of approximately 28,000 cfs was estimated with another peak flow of 43,000 cfs occurring in early December.

The fluctuation of freshwater inflow to the study area caused significant differences in the location of the salt water wedge. <sup>1/</sup> Definition of the approximate location of the saltwater wedge during the disposal operations of February-March 1974 was determined by the Bureau of Reclamation (BOR) in a study of the "entrapment zone" (18). This zone was defined as a region of high suspended solids concentration. The buildup of high suspended solids is due to saline bottom (upstream) currents transporting suspended sediments along the channel bottom to an area where the currents are nullified by the outflowing river waters, and vertical mixing of the bottom sediments and inflowing river sediments occurs. On 21 March 1974, the extent of the entrapment zone, for a freshwater inflow of 65,000 cfs, was from the westerly extent of Carquinez Strait to the Benicia-Martinez Bridge. An earlier investigation in September 1973, for an inflow of 10,000 cfs, indicated the trap zone to be located in an area approximately centered on Pittsburg.

Figures 15 and 16 show wind roses for the April-December 1974 timeframe recorded by the Bay Area Air Pollution Control District at stations in Richmond and Pittsburg. The figures also show an average wind speed for each of the sampling periods, except March 1974. Recorded winds from the two locations give an indication of the wind speeds and directions over the two largest water bodies, San Pablo and Suisun Bays, in the study area.

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<sup>1/</sup> The penetration of salt water in the lower water column into the inflowing freshwater from the Delta area.

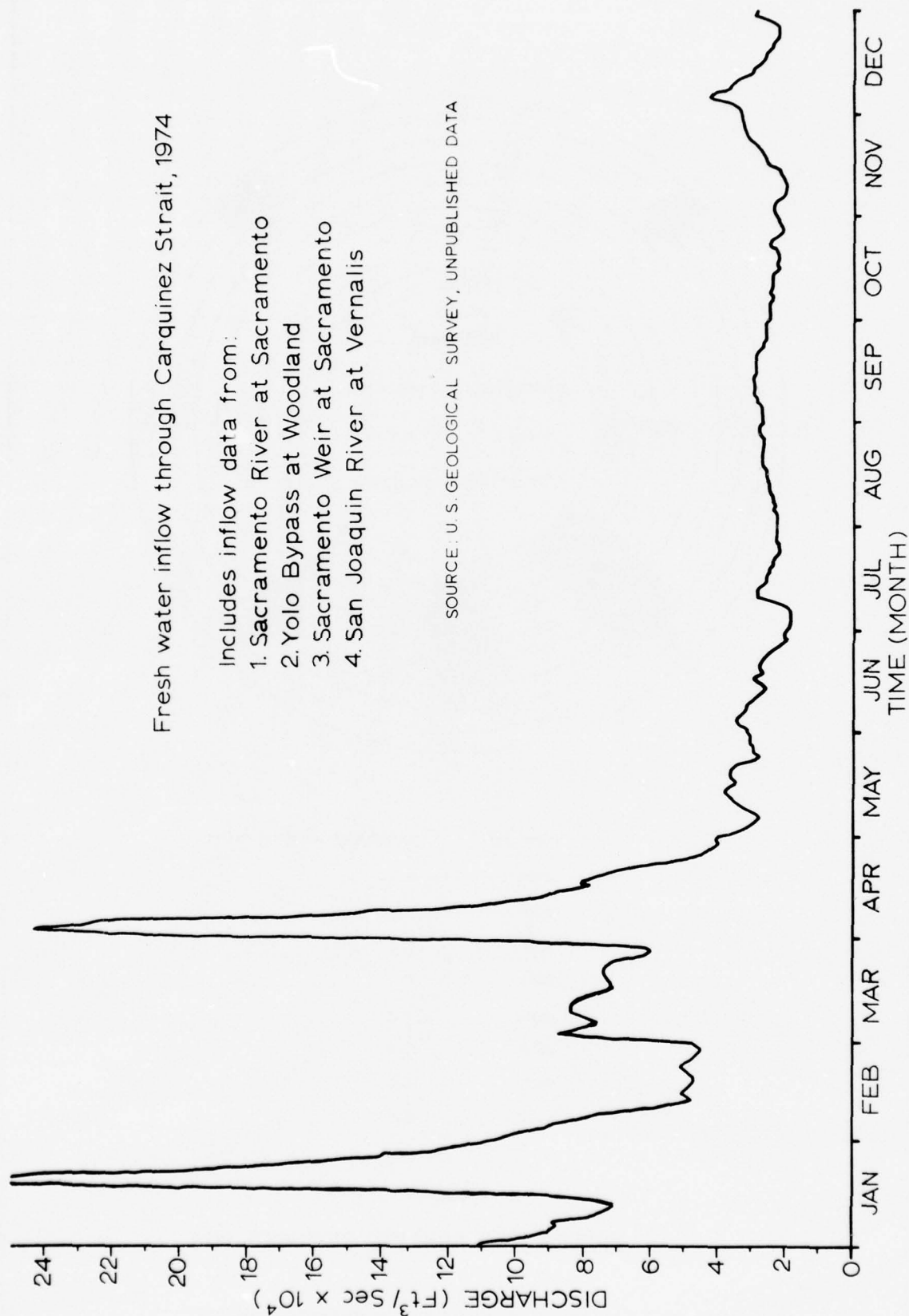
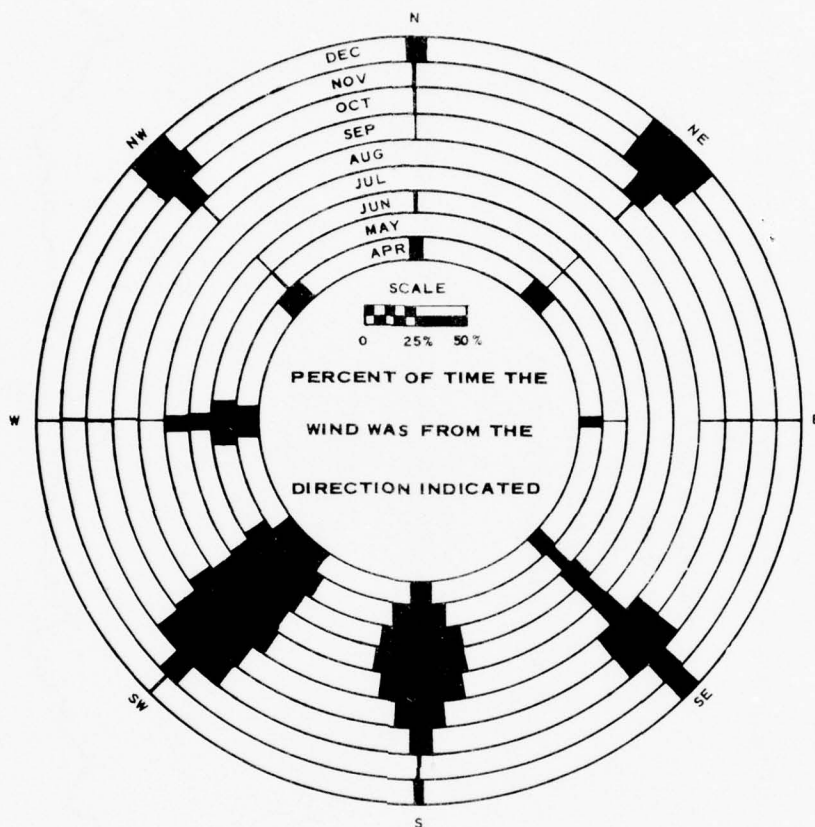


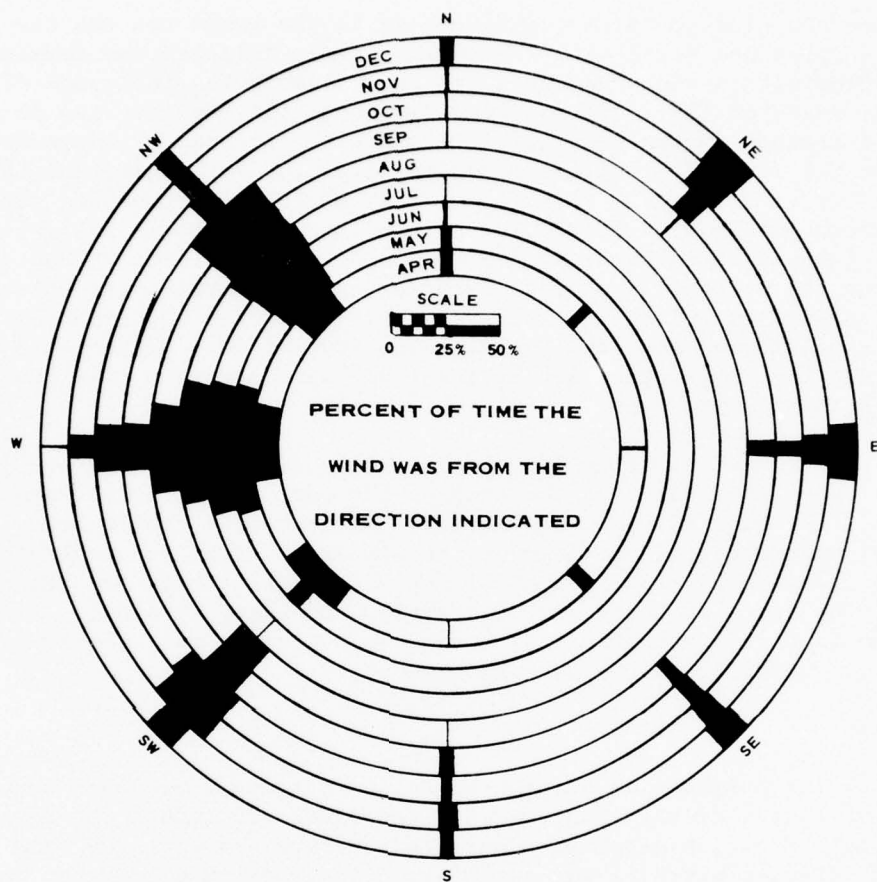
FIGURE 14



PERIOD	AVERAGE SPEED (MPH)
APR	5.4
MAY	7.1
JUN	6.8
JUL	7.5
AUG	7.3
SEP	6.5
OCT	4.6
NOV	3.7
DEC	4.6

### WIND OBSERVATIONS FOR RICHMOND, 1974

SOURCE: BAY AREA AIR POLLUTION CONTROL DISTRICT



PERIOD	AVERAGE WIND SPEED (MPH)
APR	6.1
MAY	9.2
JUN	9.3
JUL	9.2
AUG	8.4
SEP	7.7
OCT	5.3
NOV	3.8
DEC	4.6

### WIND OBSERVATIONS FOR PITTSBURG, 1974

SOURCE: BAY AREA AIR POLLUTION CONTROL DISTRICT

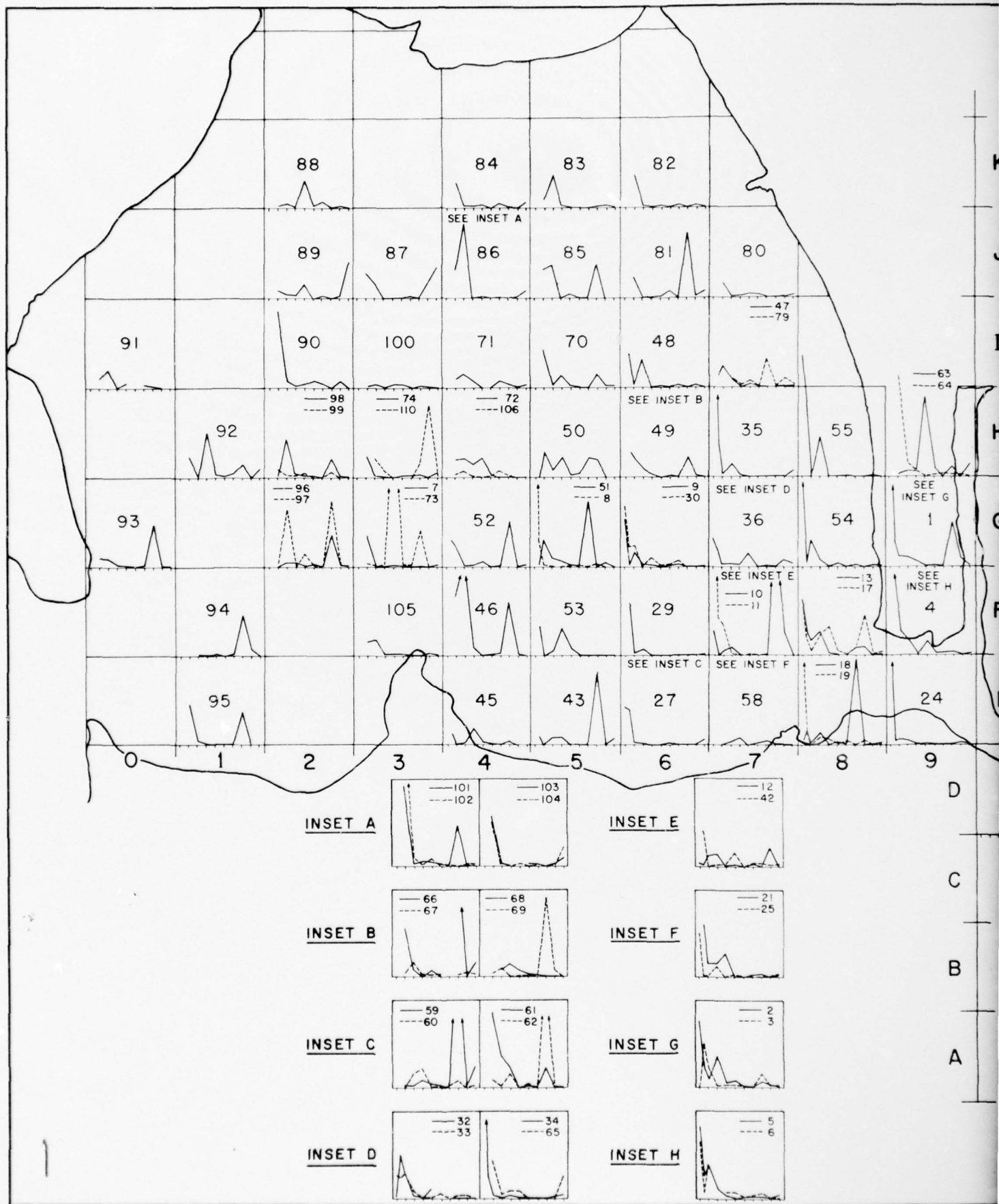
The two wind roses show differences in the winds for the two areas, both in speed and direction. These variations indicate the complexity of airflow within the study area and show clearly the influence of topographic features (19). Normal wind flow over the Bay area can be radically distorted in the very low levels due to extremes of topography, such as the low river valleys extending into the Bay region and the higher terrain, reaching elevations of 1,500 feet, surrounding the Bay. The distortion in wind flow results in major wind streams following the lines of least resistance, such as the sea level portions of the area. When the air streams encounter obstacles in the terrain, the streams split tending to follow the low areas. In Reference 19, eight basic wind types flowing over the Bay area are identified. These basic wind types are further broken down by low level wind patterns that result from the basic wind type.

The recorded winds in Figures 15 and 16 exhibit differences in the general wind flow based on the time of the year. From April through August, the recorded winds at Richmond and Pittsburg result from a general westerly flow of air over the Bay area. From September through December, westerly flows are still encountered, but they are about equally balanced by northerly, southerly, and easterly flows. Also in Figures 15 and 16, the trend of strong summer winds and slower winter winds is exhibited in the average wind speeds.

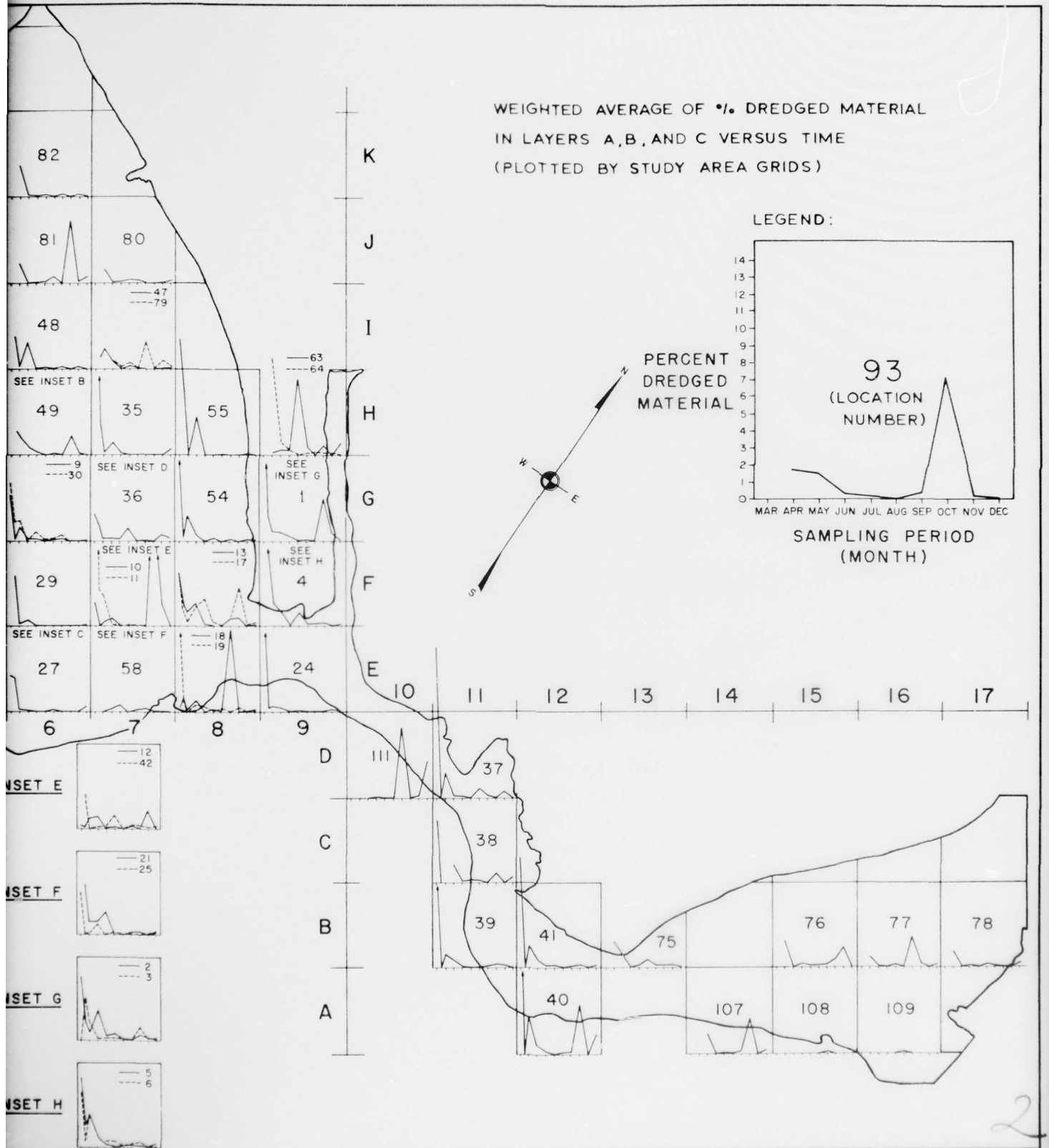
## RESULTS

The large number of samples taken and processed presents a massive problem in data display for analysis purposes. To reduce the data to a manageable form for display, a weighted average (layers A, B, and C) of percent dredged material was calculated for every sampling station for each sampling period. Figure 17 summarizes this data in the form of plots of percentage dredged material versus time for each sampling station within a major grid (Figure 7).

Sampling stations 49, 68, 67, 69 and 66 are located in the major sampling grid. The values of percent dredged material from these five locations vary significantly and illustrate that, even though some sampling locations in close proximity to one another vary similarly, uniformity of distribution within the sampling grids cannot be assumed. Uniform distribution has been demonstrated to be an incorrect assumption for the spatial separation of sampling chosen for this study, because of variations in bathymetry, current patterns, sediment transport characteristics, and sampling during random phases of the tidal cycle over a one month period. The collected data will be used primarily to identify gross changes in deposition patterns which occurred over the various sampling periods.



WEIGHTED AVERAGE OF % DREDGED MATERIAL  
IN LAYERS A, B, AND C VERSUS TIME  
(PLOTTED BY STUDY AREA GRIDS)



Two sampling periods with a reduced sampling area were selected for March while dredging and disposal operations were being performed. The portions of the study area sampled were those closest to the disposal site in San Pablo Bay and Carquinez and Mare Island Straits.

During the early March period, dredged sediments had dispersed through the entire sampled area of approximately 30 square miles. As shown in Figure 17, very high percentages of dredged material were found at the majority of sampling locations. High percentages were found in Pinole Shoal Channel, Mare Island Strait, the northern extent of the sampled areas in San Pablo Bay, and the northern and southern margins of Carquinez Strait as far eastward as Martinez. The lowest percentages were found in the southern San Pablo Bay shallows, northeast of Pinole Point and north of Dike No. 12.

In the late March sampling period the sediments at the sampled locations changed significantly. A greatly reduced level of dredged sediment was found. The higher percentages were found along Pinole Shoal Channel and the northern extent of the sampled area in San Pablo Bay.

The changes in percent dredged sediment from early March to late March indicates a general dispersal and mixing of sediments in the sampled area and possibly throughout the study area. As time from the initial disposal operation increases, the sediments are dispersed over an increasing area and are found in smaller concentrations over the study area. The changes from early March to late March show a trend of westerly movement of dredged sediments into San Pablo Bay. In addition, dredged sediments are moving back into the dredged channel while dredging operations are in progress.

The relatively high freshwater inflow in March (Figure 14) and associated high sediment inflow could partially account for the high concentrations of dredged sediment found near the disposal site in early March. As described by Krone in Reference 10, the high freshwater inflow and sediment load would increase interparticle collisions between the dredged sediment and inflowing sediments and cause formation of "aggregates of cohesive particles where settling velocities are relatively large."

Sampling during April encompassed the entire study area and was accomplished after cessation of dredging and disposal operations. Dredged sediments were dispersed throughout most of San Pablo Bay, Carquinez Strait, Suisun Bay and Mare Island Strait. Localized areas of high percentages of dredged sediments were found in the northwestern shallows of San Pablo Bay, off Pinole Point, and in the southeastern shallows of San Pablo Bay. The intermediately high percent dredged sediments areas were found in the southern shallows of San Pablo Bay

between Pinole Point and Point San Pablo, the northern shallows of San Pablo Bay, Mare Island Strait, Benicia and Martinez, and the west end of Suisun Bay.

In May the levels of percent dredged sediments were significantly lower than in April and more samples showed no dredged sediments. The high percentages of dredged sediments were found north and northwest of Pinole Point and in a small area of the northern San Pablo Bay Flats. As in April the sampling locations with the higher percentages of dredged sediments were concentrated in San Pablo Bay.

There are several possible explanations for the drop in the level of percent dredged sediments from April to May: some of the dredged sediments left in the study area moving into Central Bay; the dredged sediments moved into areas other than those sampled, such as marshes or wetlands, around the periphery of the study area; the dredged sediments mixed with other sediments or were covered to depths greater than 9 inches. Actual disappearance of the sediments is due to a combination of the aforementioned reasons.

The predominantly westerly direction of the wind (Figures 15 and 16) in May creates a long fetch for the generation of wind waves over the extensive northern San Pablo Bay shallows and the eastern Suisun Bay shallows. The increase in wind speed from April to May would increase the ability of the wind-generated waves to suspend sediments for transport by tidal currents to lower energy areas.

In June, July, and August significant reductions in the levels of percent dredged sediments from levels in April and May were observed. By the end of August, five months after completion of dredging, very little dredged sediment was found over the 100 square mile study area in the top 9 inches of sediments.

Of the three sampling periods, July has the relatively highest level of percent dredged sediment. Thus, the decay of percent dredged sediment is not constant; although the levels seen in July are significantly lower than those in April and May. The levels in August are smaller than those in any of the previous sampling periods.

The absence of widespread, high concentrations of dredged sediment in June, July, and August can be attributed to the relatively high westerly winds generating waves over the northern shallows of San Pablo Bay and the northeastern shallows of Suisun Bay. These waves would constantly resuspend and circulate sediments in the shallows, which constitute the largest portion of the study area.

In September the levels of percent dredged sediments experienced were similar to those in July. However, in July the concentrations of dredged sediments were located in San Pablo Bay and very little in Suisun Bay; while in September large concentrations of dredged sediment were located in Suisun Bay.

The September sampling was completed prior to the fall dredging cycle, which began on 20 September. The increase in dredged sediment found in September from that in August is not attributed to redredging of the February-March 1974 sediments in Mare Island Strait and dispersal through the study area. Since the source for the dredged sediments found in September was the same for June, July, and August, the reappearance has to be associated with factors affecting recirculation. In Figures 15 and 16, the wind pattern for September shows a shifting of direction and reduction in the speeds from those in the May-August timeframe. The wind direction in September, although predominantly westerly, shows a distinct shift towards northerly, southerly, and easterly directions. The change in the wind patterns could be a partial explanation of the reappearance of dredged sediments in September.

The October sampling, conducted during dredging operations in Mare Island Strait with disposal in Carquinez Strait, revealed a significant increase in the levels of dredged sediment over those found in September.

Comparison of October and early March, when dredging operations were also being conducted, shows several similarities. For both sampling periods high concentrations of dredged sediments were found between Pinole and Davis Points in San Pablo Bay, along the channel margins of Pinole Shoal Channel, in Pinole Shoal Channel, and on the south side of Carquinez Strait west of Martinez. Late March is not similar to either early March or October. April shows similar trends in the higher concentrations of percent dredged sediments as seen in October.

The reappearance of high concentrations of dredged sediments in October can be attributed to two causes; the first is the estuarine process of sediment recirculation, and the second is the redredging of tagged sediments from Mare Island Strait and subsequent dispersal in the study area. The relative importance of either of the two causes on the increased buildup in percent dredged sediments levels from September to October is difficult to quantify. The quantity of sediment returning to Mare Island Strait for redredging will be discussed in a subsequent section, and a change in the estuarine processes caused by changes in climatic conditions is discussed in the following paragraph.

In October, as shown in Figures 15 and 16, wind directions continued to shift to northerly and easterly directions with a further decrease in average wind speed. This pattern of changing directions and speed would tend to increase the movement of sediments away from the northern shallows and increase the deposition rate of suspended sediments, particularly in the shallows and channel margins of the study area. In October dredged sediments were found in the southern and, to a limited extent, northern San Pablo Bay shallows, the channel margins and natural channel in San Pablo Bay, and most of Suisun Bay with the exception of the eastern shallows. The dredged sediments found in the natural channels could result from tidal currents transporting newly deposited sediments from the channel margins.

In November and December much of the dredged sediments that had been located in September and October had disappeared. In November there was only one isolated area, northwest of Pinole Point, where percent dredged sediment exceeded 4 percent. In December, two areas, the northwestern shallows of San Pablo Bay and hole 111 in Carquinez Strait, exceeded 4 percent.

In summary, Figure 17 shows that dispersion of dredged sediments after disposal at the Carquinez disposal site was very rapid. During the dredging operation, dredged sediments make up a large percent of the total sediment in and around the disposal site, including dredged sediments that had re-entered the dredged channel. After the completion of dredging operations at Mare Island Strait, dredged sediments were found dispersed (in April) over a 100 square mile area including San Pablo Bay, Carquinez Strait and Suisun Bay. Localized areas were found in San Pablo Bay of high percentages of dredged sediments. In May and June the dredged sediments located in the study area decreased significantly. By August, five months after completion of dredging, little evidence of dredged sediment was found in sampled sediments over the study area. However, in September tagged sediment reappeared in the sampled sediments. In October dredged sediments in the study area increased significantly over that found in September. By December, two months after the second dredging cycle, most of the dredged sediments had again disappeared from the study area.

Horizontal Distribution of Dredged Sediments. To provide a better feel for the horizontal distribution (over the 9-inch depth of sediment) of dredged sediments in the study area for the various sampling periods, graphical displays of the weighted average of the percent dredged sediment data and calculations of dredged sediment volumes were made.

The graphical displays were produced using the AUTOMAP II computer mapping program developed by the Environmental Systems Research Institute of Redlands, CA. The program comprises a computer graphic system written in Fortran IV language, which produces various types of maps displaying qualitative and quantitative information. The initial work in keypunching the data for use with the AUTOMAP II program and the computer graphics for the study area was accomplished by the Corps' Hydrologic Engineering Center in Davis, CA. The final updating of the data files and generation of a complete set of graphical displays was accomplished by the San Francisco District.

The AUTOMAP II system consists of three computer programs, BASE MAP, AREA MAP, and CONTOUR/PROXIMAL MAP, which generate choropleth, contour and proximal maps. For the percent dredged sediment displays the BASE MAP was used to generate the outline of the study area, and the CONTOUR/PROXIMAL MAP program was used to generate the graphical data within the study area boundaries. The CONTOUR/PROXIMAL MAP program assigns values for percent dredged sediment to the sampled locations

within the study area and then interpolates a value of percent dredged sediment for each grid cell of the geographic matrix, based upon the distance and direction from the assigned number of sampled locations. Each grid cell represents a surface area of 1,100 feet by 660 feet. The interpolation scheme uses the inverse of the square of the distance between the data points and the grid cell for assignment of grid cell values. For these displays a maximum of three closest data points were used to interpolate values of percent dredged sediment for each grid cell.

To produce the graphical displays the samples taken during a sampling period were treated as though they were all taken at the same time, even though they were actually taken up to two weeks apart. Also, the values of percent dredged sediment in Inclosure 2, which are greater than 100 percent, were assigned values of 99 percent for purposes of the graphical displays since values of greater than 100 percent are theoretically impossible.

To give quantitative significance to the visual displays of dredged sediment distribution, calculations converting percent dredged sediment to an in-situ volume were made. Caution should be used in considering the volume data. As mentioned earlier, accurate grid sediment budgets cannot be calculated. Therefore, the dredged sediment volumes calculated should not be considered as representing actual volumes, but in the relative context of providing a capability of assessing changes from one sampling period to another.

The calculations used the AUTOMAP II program with an additional routine added which would sum up the various values in the grid cells. Only the top 9 inches (Layers A, B, and C) of sampled sediments were included in the calculations, and the volume of dredged sediment in each layer was calculated individually.

The calculation of dredged sediment volumes in the study area is subject to the following assumptions and limitations:

- (1) The dredged sediment within a grid cell of the AUTOMAP II program is uniformly distributed in that grid cell, both horizontally and vertically.

- (2) The data values for grid cells vary as the inverse square of the distance from surrounding sampled locations.

- (3) The samples taken during each sampling period are assumed to have been taken on the same tidal cycle; even though they were actually taken up to two weeks apart.

The conversion of percent dredged sediment to a quantity of dredged sediment released was accomplished by first multiplying the dry density ( $gdry/cc_{wet}$  in Inclosure 2) of each sample by percent dredged sediment.

The product of these two numbers yields a density of dry dredged sediments. This product then became the data value for each sampled location, and values were assigned to each grid cell in the study area based on the CONTOUR/PROXIMAL MAP interpolation scheme. After assigning values to each grid cell, the values in the appropriate cells were summed and the sum multiplied by a factor which included the volume of the appropriate layer (either A, B, or C) for one grid cell and a factor to convert the weight of dry dredged sediments to an in-situ volume of dredged sediment.

The calculational concept is illustrated in the following sequence:

$$V = \frac{W_s}{\gamma_d} \quad (2)$$

where:  $V$  = volume of dredged sediment (wet density = 1.3 g/cc) in one grid cell,  $\text{yd}^3$ .

$\gamma_d$  = dry density of dredged sediment from Mare Island Strait = 0.5 g/cc

$W_s$  = weight of dry dredged sediment in one grid cell which was calculated as follows:

$$W_s = (g_{\text{dry/cc}_{\text{wet}}}) (\% \text{D.M.}) (V_A) \quad (3)$$

where:  $g_{\text{dry/cc}_{\text{wet}}}$  = dry density of sediments in a sampled increment (Inclosure 2)

% D.M. = percent dredged sediment value for sampled increment (Inclosure 2)

$V_A$  = volume of layer A, B, or C in one grid cell.

The volumes of dredged material in the individual grid cells were then summed to provide the total volume.

Graphical Displays. The graphical displays for the weighted averages of percent dredged sediment for each sampling period are shown in Figures 18-28. Table 4 is a legend showing the map symbols, the range of percent dredged sediment for each map symbol, the percent of the study area covered by each map symbol for each sampling period, and the maximum value of percent dredged sediment for each sampling period.

Table 4

## PERCENT OF STUDY AREA COVERED BY PERCENT DREDGED SEDIMENT

Percent of Area Covered by Percent Dredged Sediment By Sampling Period													
Level Number	Symbol for Percent Dredged Sediment	Value Range of Percent Dredged Sediment	Percent of Area Covered by Percent Dredged Sediment By Sampling Period										
			Early March	Late March	April	May	June	July	August	Sept	Oct	Nov	Dec
Low	LLLLLL	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	LLLLLL	0.0	7.69	20.75	17.78	26.04	59.79	62.89	85.57	71.13	50.51	79.38	70.71
2	.....	0.5	2.56	22.64	28.89	43.75	27.84	27.84	14.43	22.68	19.19	15.46	20.20
3	.....	2.0	2.56	20.75	18.89	19.79	8.25	6.19	0.00	1.03	8.08	3.09	6.06
4	+++++	4.0	5.13	18.87	20.00	5.21	3.09	1.03	0.00	2.06	3.03	1.03	1.01
5	+++++	6.0	7.69	9.43	5.56	2.08	1.03	0.00	0.00	0.00	7.07	0.00	2.02
6	000000	8.0	10.26	3.77	2.22	1.04	0.00	0.00	0.00	0.00	3.03	0.00	0.00
7	000000	10.0	33.33	3.77	5.56	2.08	0.00	1.03	0.00	3.09	7.07	1.03	0.00
8	000000	20.0	15.38	0.00	1.11	0.00	0.00	1.03	0.00	0.00	2.02	0.00	0.00
9	000000	40.0	15.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	000000	80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High	HHHHH	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Highest Value	HHHHH	100.0	48.90	16.61	25.46	16.80	7.72	30.49	1.62	14.82	25.18	12.44	6.46



FIGURE 18

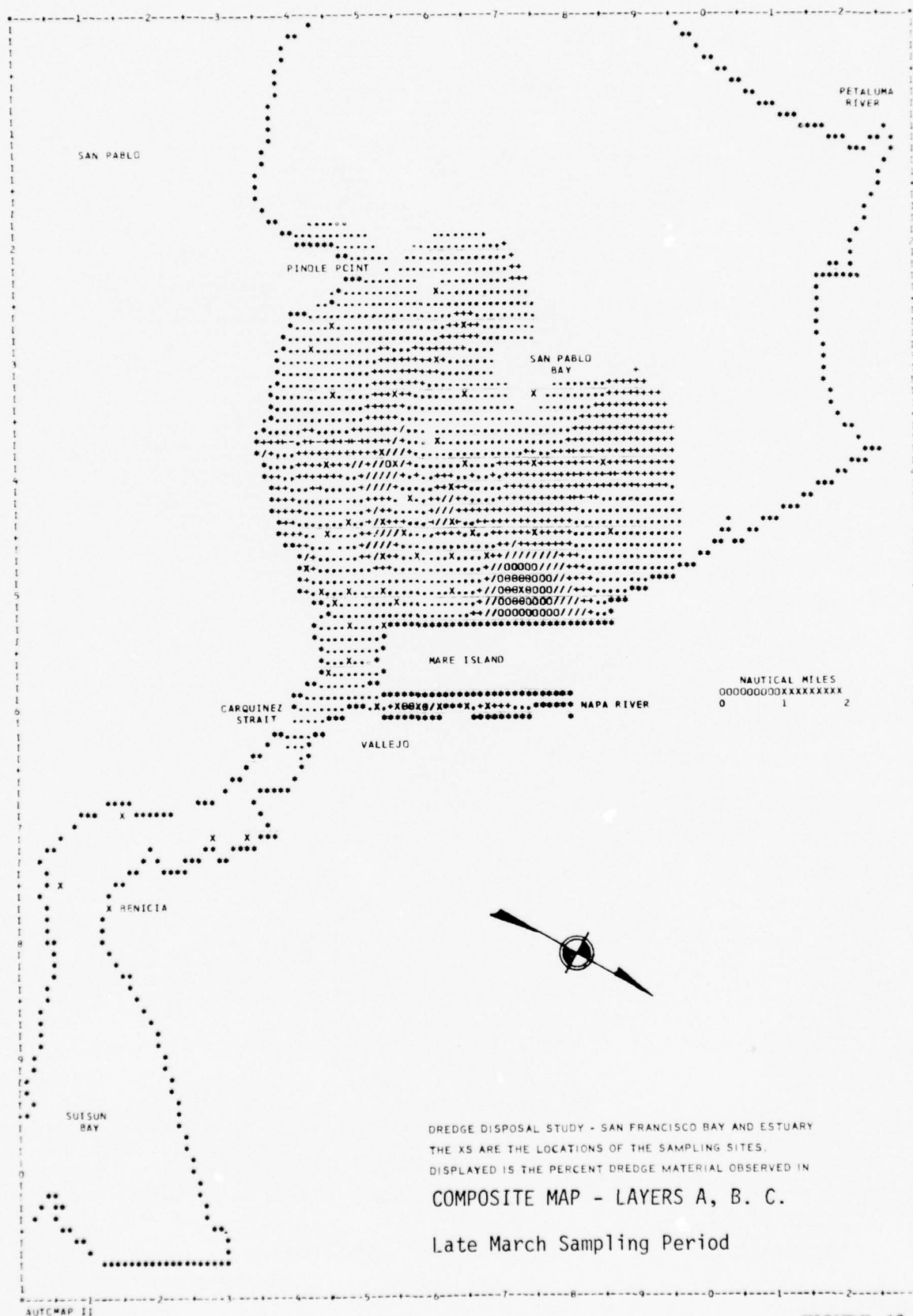


FIGURE 19



FIGURE 20



FIGURE 21

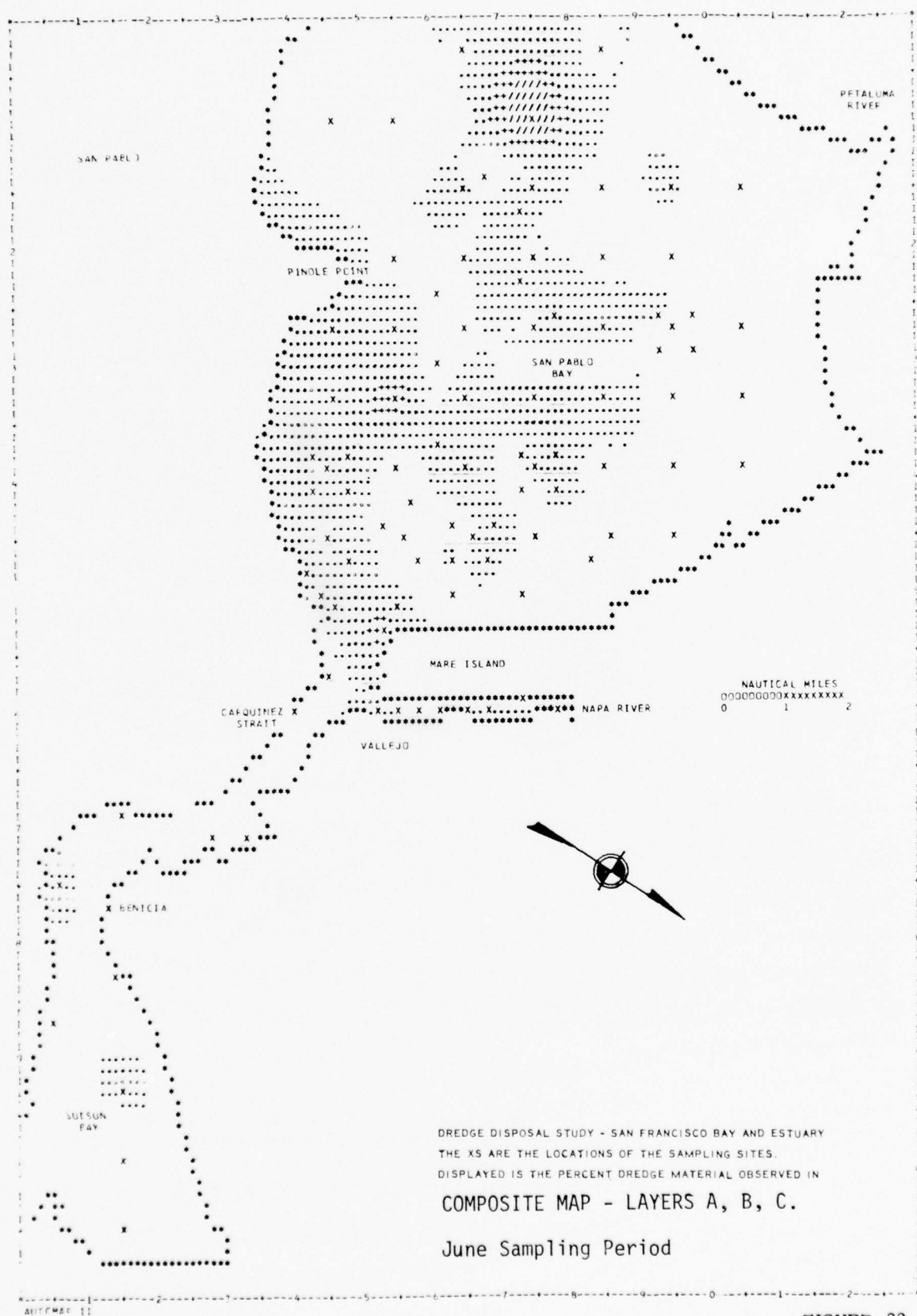


FIGURE 22

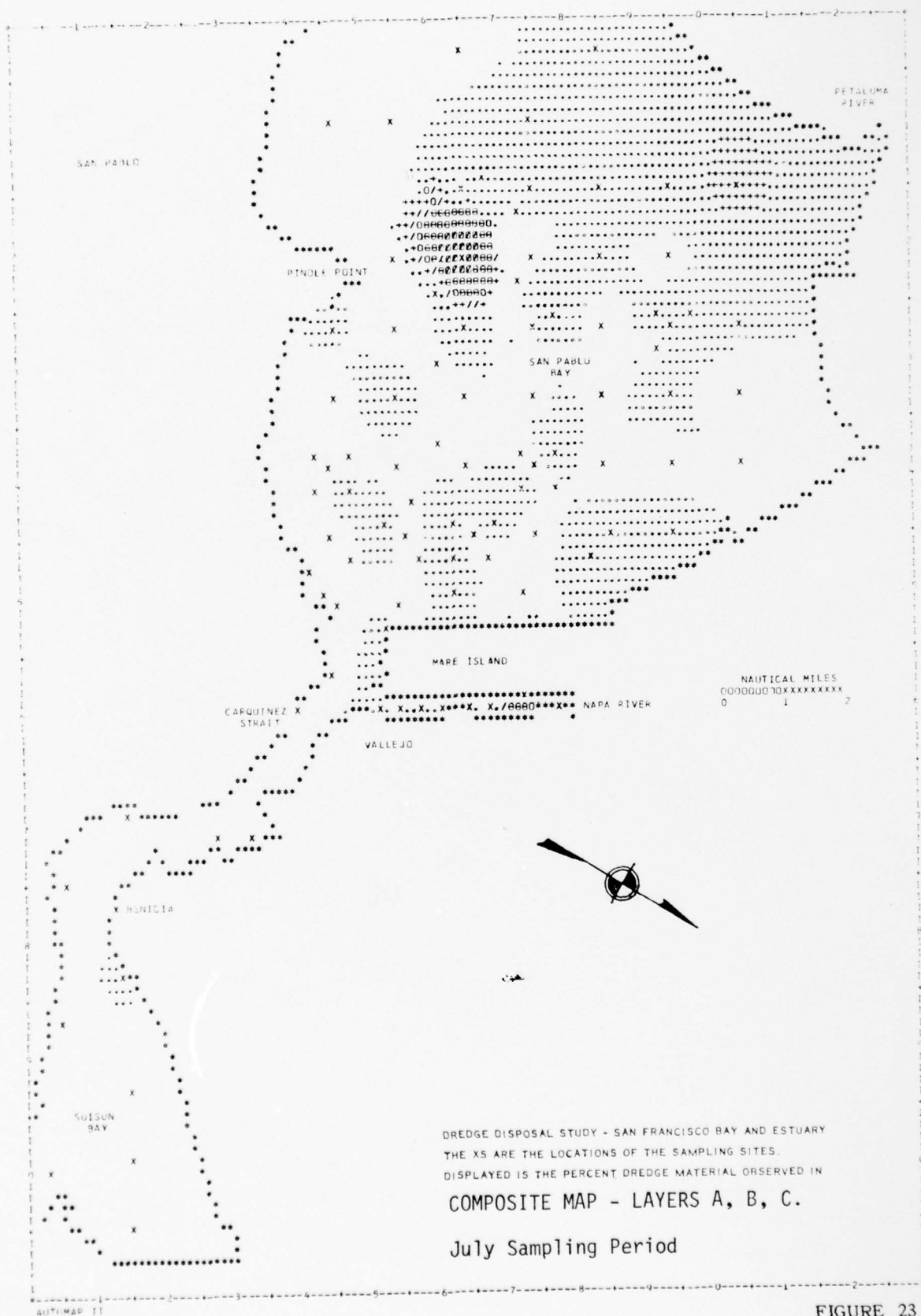


FIGURE 23

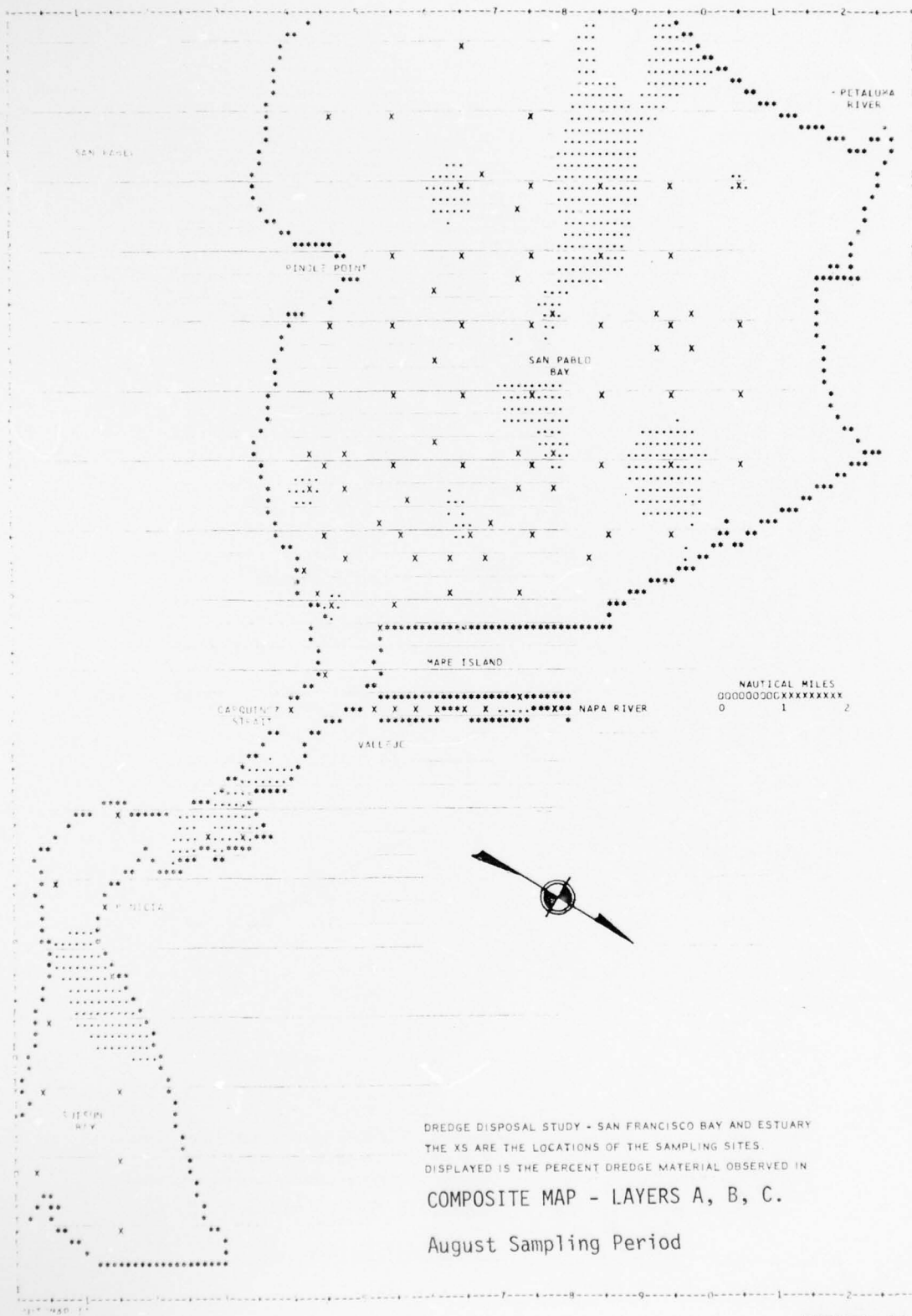


FIGURE 24



FIGURE 25

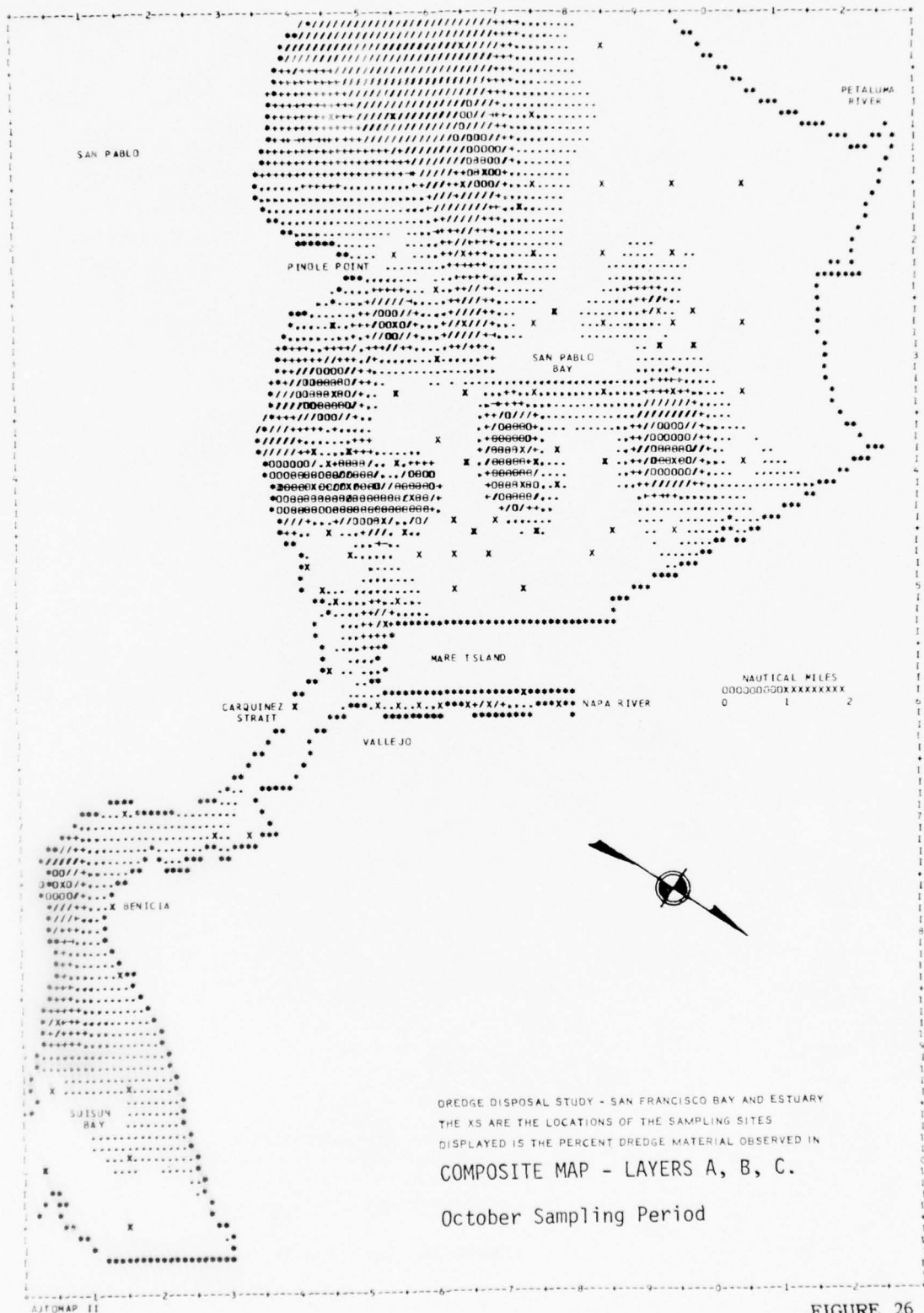


FIGURE 26

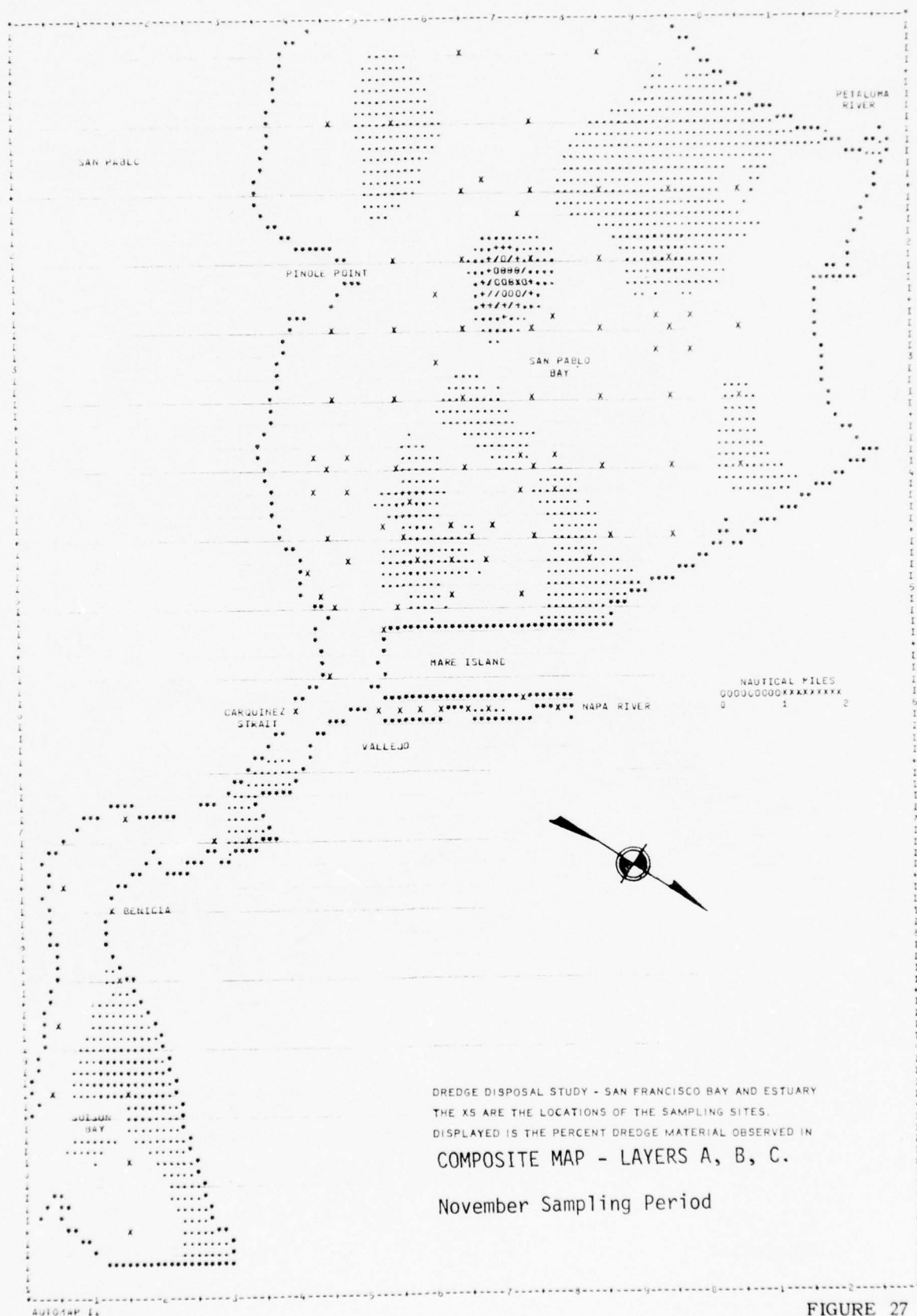
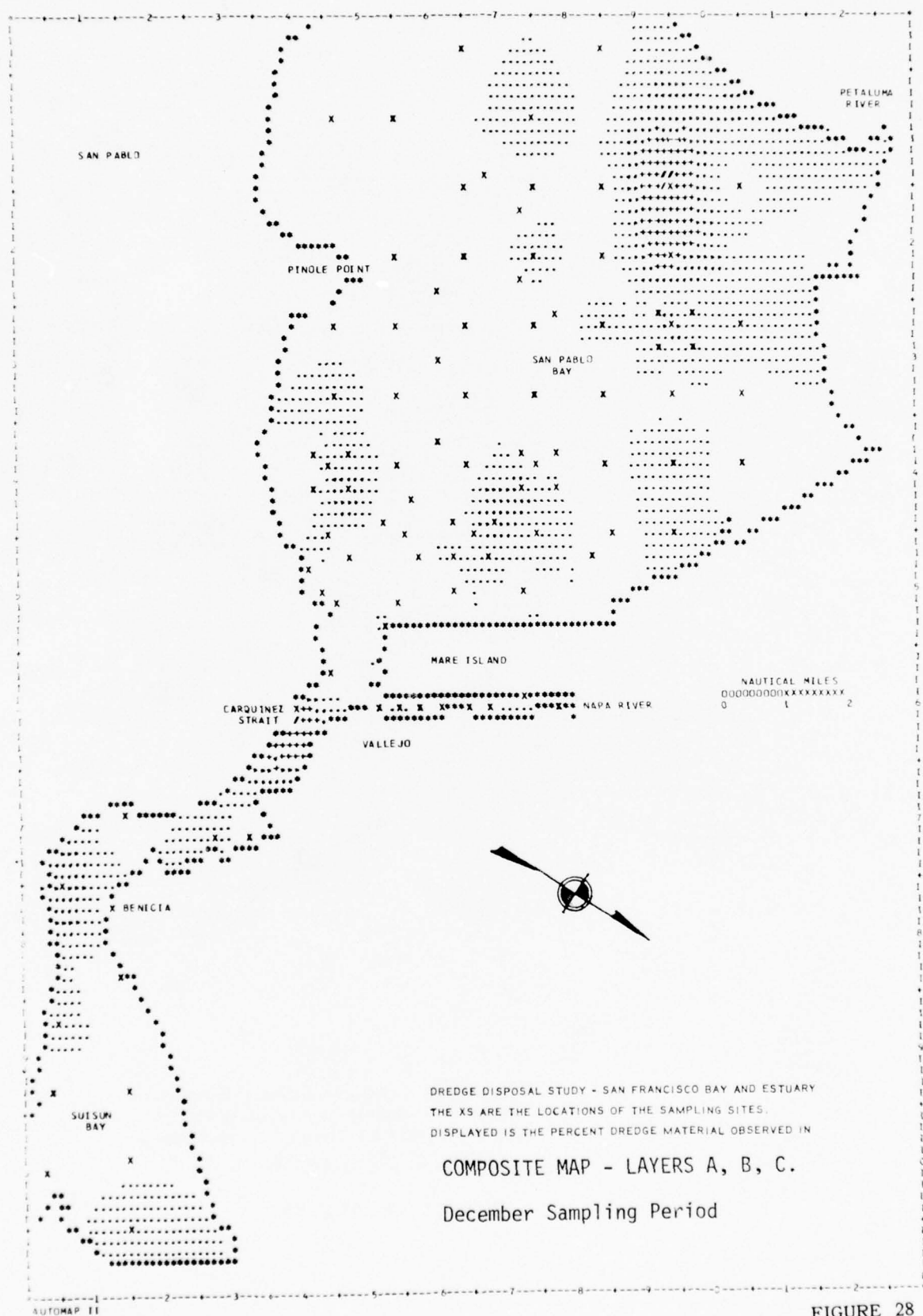


FIGURE 27



Figures 18-28 (qualitative display) show essentially the same information as Figure 17 (quantitative display), except that each sampling period is displayed separately, which makes easier visual perception of the horizontal distribution of dredged sediments within a sampling period and comparison of the various sampling periods. Figure 29 plots information on the percentage of the study area covered by various map symbols for each sampling period presented in Table 4. The percentage dredged sediment values are broken down into four ranges, 0-0.5%, 0.5-4%, 4-8%, and >8%, for ease in visual perception. The early and late March sampling periods were not plotted, due to their limited sampling area. Straight lines were used to connect points in Figure 29, because the actual variation between sampling periods is not known.

Figure 29 shows that as time increases from dredged sediment disposal, the percentage of the study area having very low values (0-0.5%) of percent dredged sediment increases until a peak is reached in August. The other ranges of percent dredged sediment decrease to a low in August. This illustrates, as also shown in Figure 17, that a large amount of dredged sediments are concentrating in October after essentially disappearing from the top 9 inches of sediments in the study area during the May-August periods. In November and December the levels of percent dredged sediment show a reduction from those in October.

**Dredged Sediment Volumes.** Dredged sediment volumes for the study area were calculated for layers A, B, and C for the April-December sampling periods to gain further insights and to compare the relative differences in levels of percent dredged sediment (displayed on Figures 20-28) found in specific parts of the study area. Volumes were calculated for the total study area, San Pablo Bay, Suisun Bay, and Carquinez and Mare Island Straits. The total volumes (including layers A, B, and C) for each of these areas is shown in Table 5. The volumes calculated for each area for layers A, B, and C are given in Inclosure 3.

Comparison of the volumes in Table 5 for the various areas is difficult because of the difference in size of the various areas. Figure 30 is a plot of the variation in dredged material volume for each area by sampling period. The data is plotted on a volume/area (cubic yards/square mile) basis for ease of comparison. Inspection of the various plots in Figure 30 shows that, on an area basis, the deposition of tagged sediments during April is almost twice as high in Suisun Bay as it is in other parts of the study area where deposition is about equal. All areas show decreases in May with Suisun Bay having the largest. In June and July Carquinez Strait and Suisun Bay both show low levels of dredged material. Mare Island Strait and San Pablo Bay both show relatively low volumes/area in June; however, both show increases in July.

# VARIATION IN COVERAGE OF THE STUDY AREA BY PERCENT DREDGED MATERIAL VALUES

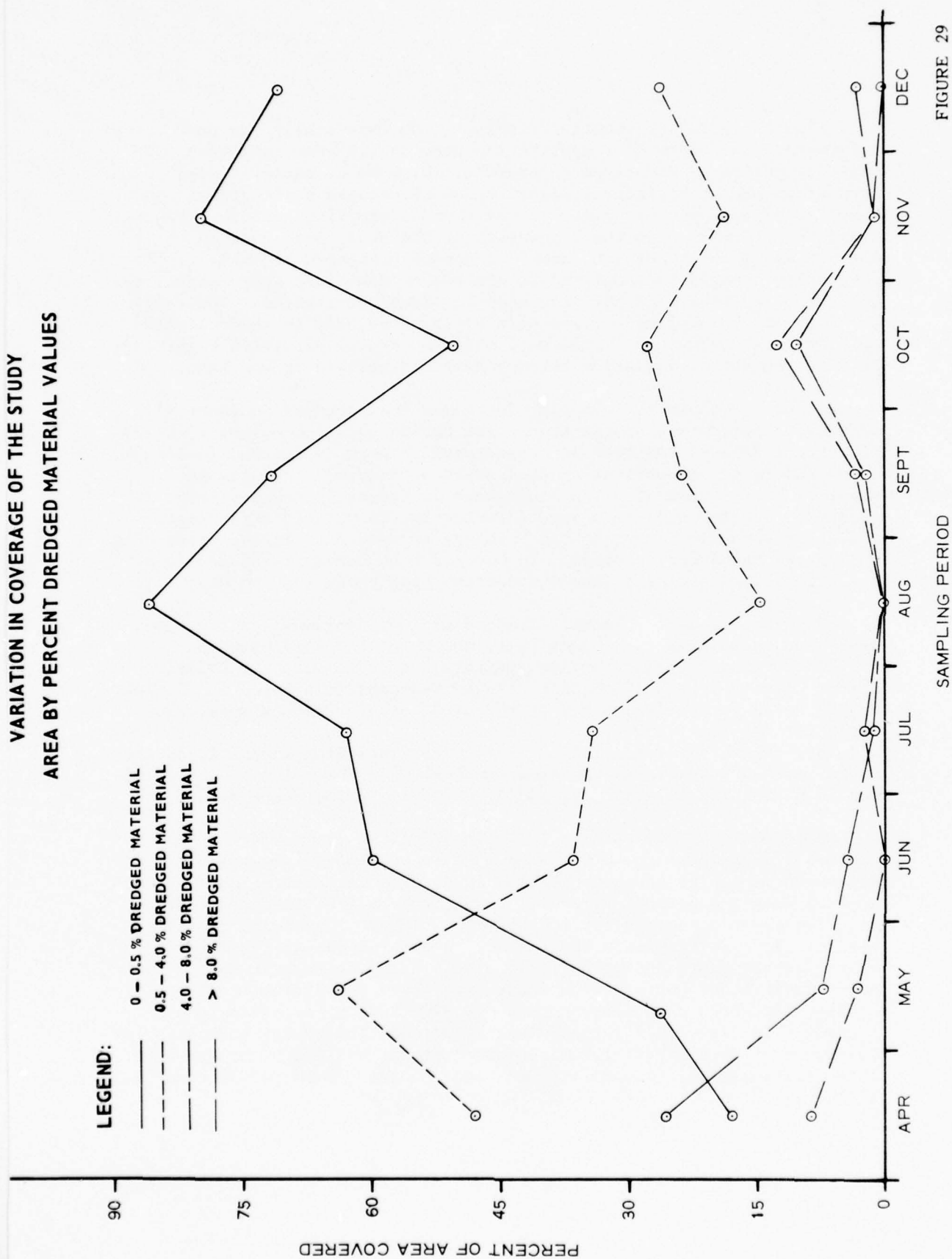
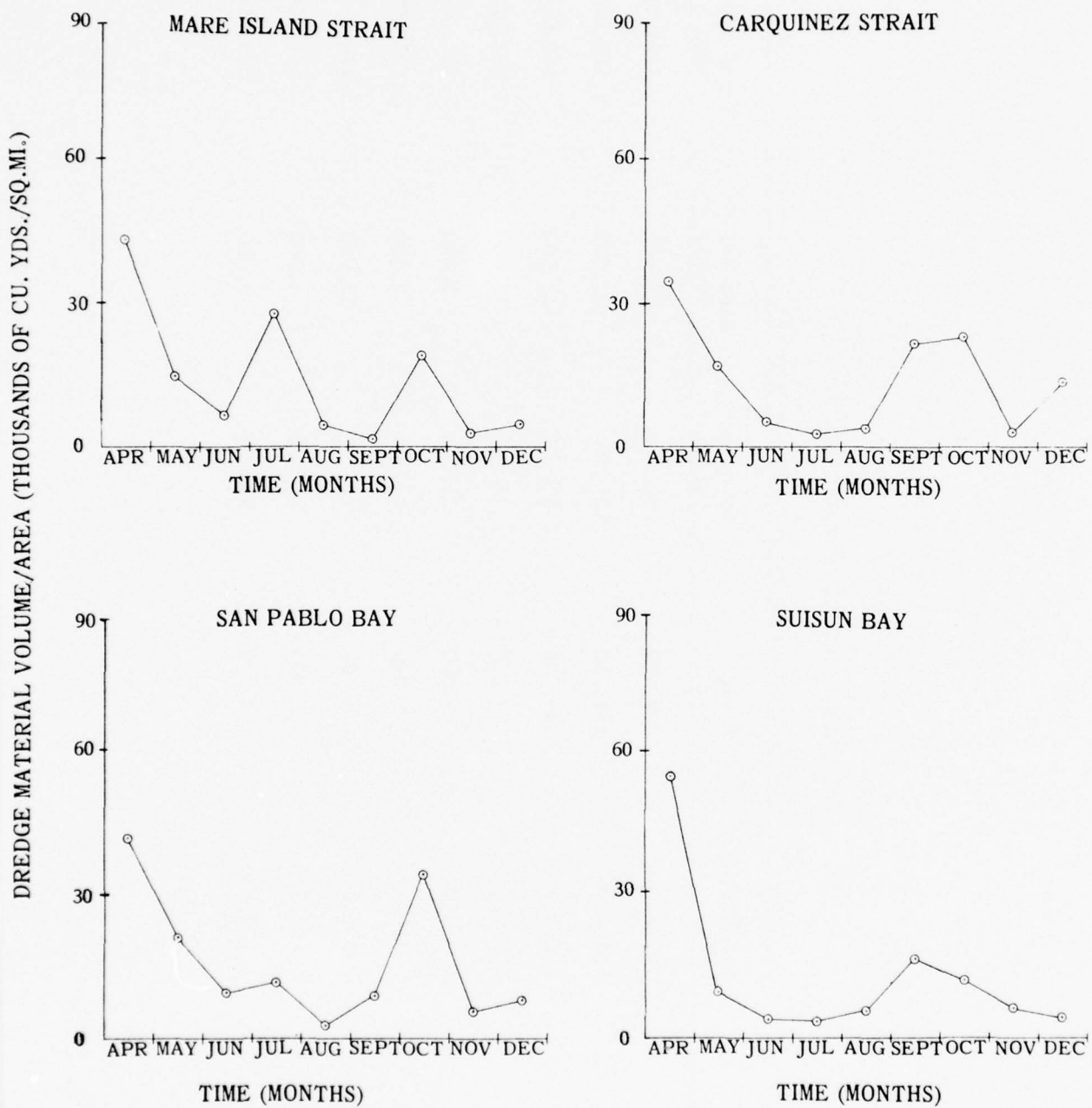


FIGURE 29

Table 5

## CALCULATED DREDGED MATERIAL VOLUMES

Sampling Period	Volume of Dredged Material by Area (yd <sup>3</sup> )					Total Study Area
	San Pablo Bay	Suisun Bay	Carquinez Strait	Mare Island Strait		
April	3,729,000	702,000	261,000	57,000		4,749,000
May	1,893,000	131,000	127,000	21,000		2,172,000
June	865,000	50,000	39,000	11,000		965,000
July	1,279,000	46,000	22,000	34,000		1,381,000
August	250,000	75,000	31,000	5,000		361,000
September	814,000	215,000	163,000	2,000		1,194,000
October	3,067,000	159,000	175,000	23,000		3,424,000
November	495,000	81,000	24,000	4,000		604,000
December	709,000	60,000	99,000	8,000		876,000



Dredged Material Volume /Area Versus Time for San Pablo and Suisun Bays and Carquinez and Mare Island Straits

FIGURE 30

A low level of dredged material/area appears throughout the study area during the August sampling period. During September the volume/area decreases in Mare Island Strait and increases significantly in Carquinez Strait, Suisun Bay, and San Pablo Bay. The October sampling period shows relatively high volume/area values, particularly in San Pablo Bay, to a lesser extent in Mare Island Strait, a slight increase over September in Carquinez Strait, and a reduction from September in Suisun Bay. In November and December the volume/area values for all four areas drops down to what would appear a residual value similar to the June, July, and August values. The exception is a rather sharp increase in Carquinez Strait in December.

Calculation of dredged material volumes was also made of twelve sections based on bottom bathymetry. The sections had water depths in one of three depth ranges: 0-6 ft MLLW, 6-18 ft MLLW, and > 18 ft MLLW. The three depths were chosen to categorize the sections into shallow depth areas (such as mudflats), channel margins, and channel areas. The breakdown of the study area into the various section is shown in Figure 31. Along with the map symbol for each section on Figure 31 is the section number, the depth range of the section, and the percent of study area the sections covers. The total volumes calculated for each section by sampling period is shown in Table 6. A detailed breakdown of these calculations for layers A, B, and C is in Inclosure 3.

The data in Table 6 has been plotted in Figure 32 on a volume/ area basis similar to Figure 30. The plots in Figure 32 show the areas where dredged sediments concentrated under the varying conditions of the study period.

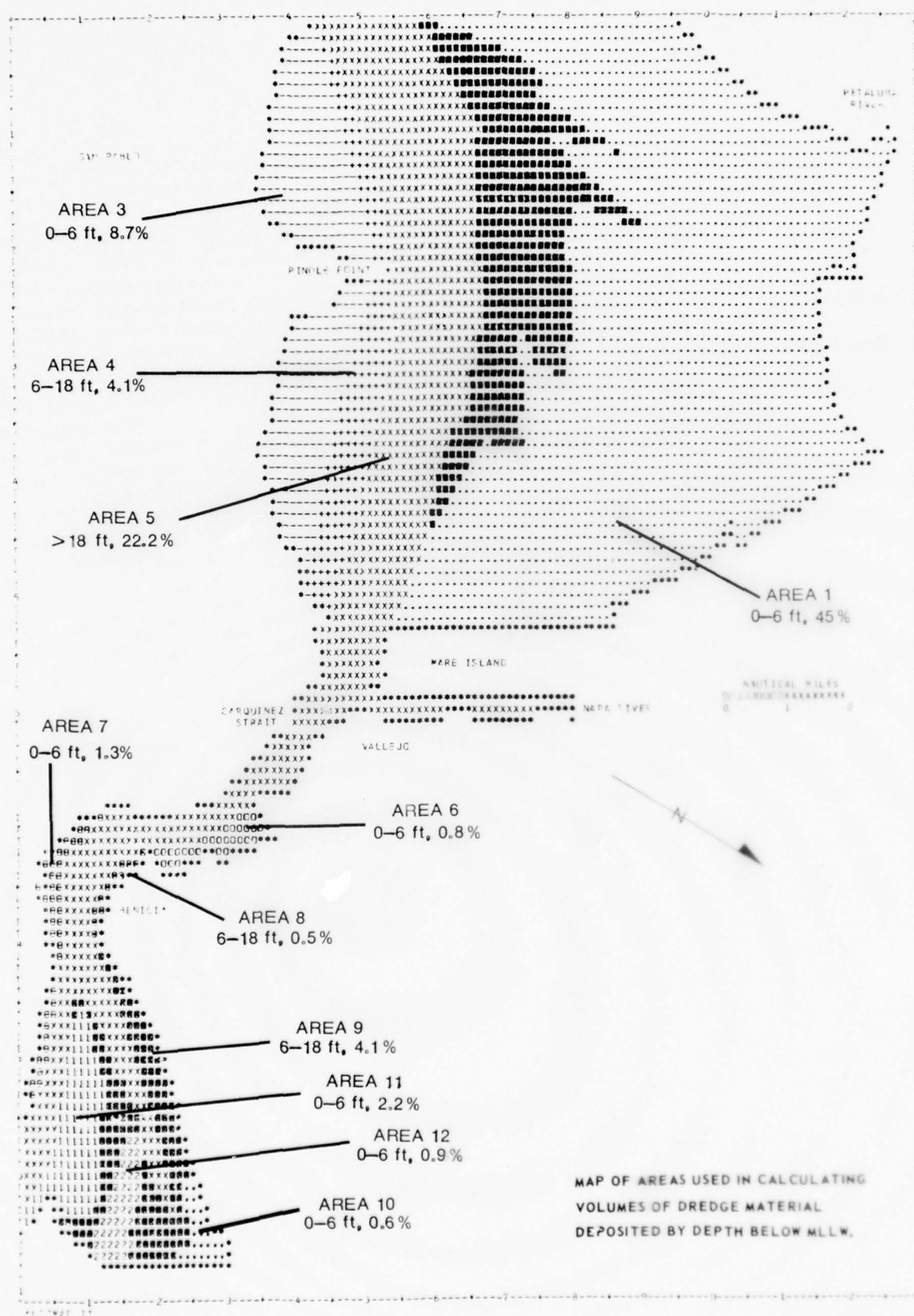


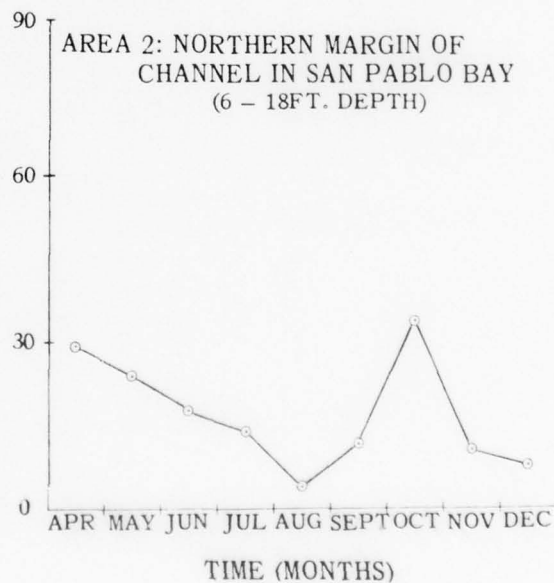
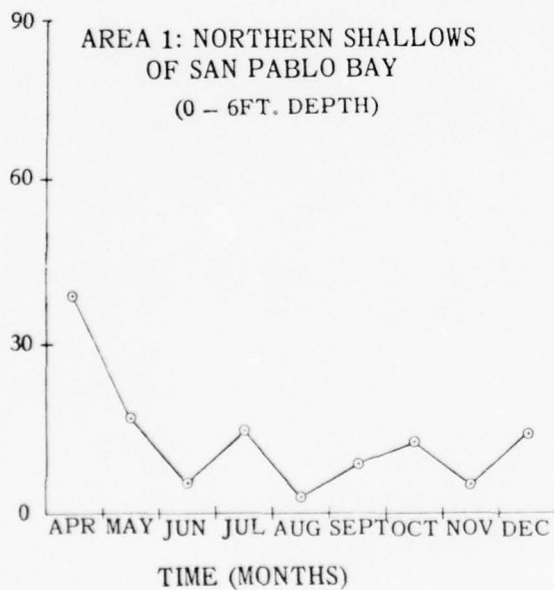
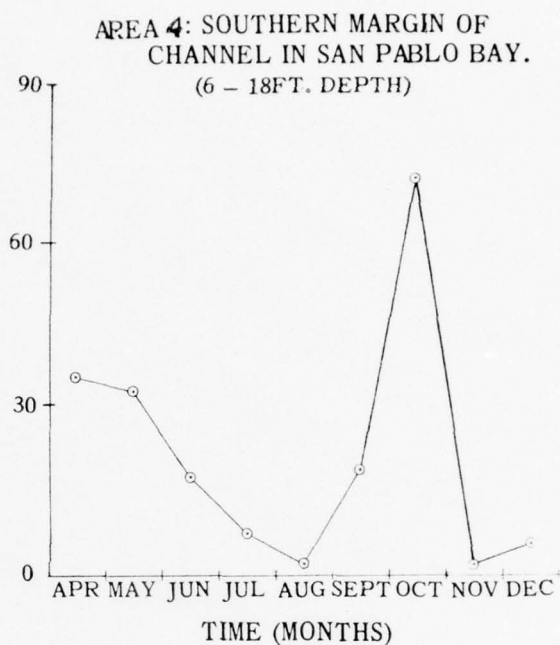
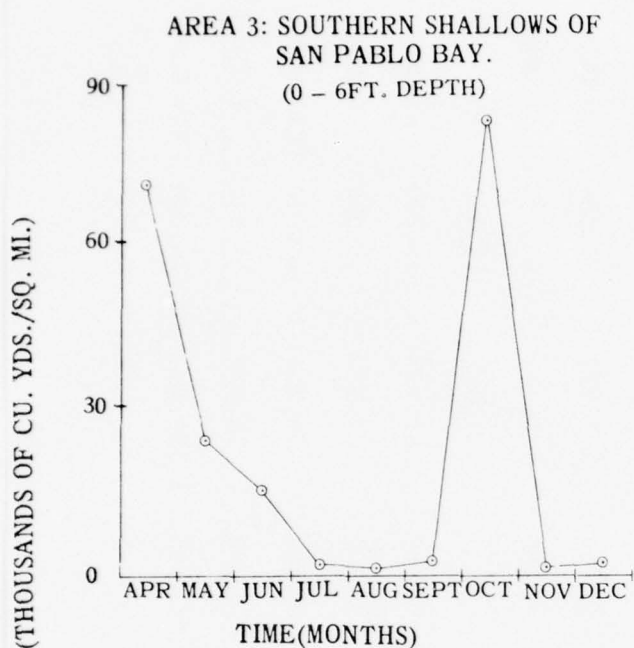
FIGURE 31

Table 6

## CALCULATED DREDGED MATERIAL VOLUMES

## Volumes of Dredged Sediments by Sampling Period

Section	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	1,981,000	1,008,000	282,000	751,000	156,000	442,000	642,000	268,000	600,000
2	315,000	228,000	195,000	153,000	39,000	127,000	360,000	104,000	38,000
3	685,000	209,000	151,000	20,000	17,000	25,000	801,000	17,000	22,000
4	167,000	154,000	83,000	17,000	9,000	87,000	329,000	9,000	28,000
5	993,000	465,000	206,000	403,000	75,000	319,000	1,107,000	140,000	117,000
6	25,000	18,000	2,000	3,000	9,000	5,000	7,000	6,000	6,000
7	86,000	37,000	6,000	2,000	4,000	9,000	100,000	1,000	17,000
8	18,000	8,000	1,000	1,000	0	1,000	4,000	0	2,000
9	255,000	24,000	21,000	18,000	32,000	97,000	40,000	41,000	23,000
10	37,000	0	4,000	2,000	4,000	17,000	5,000	4,000	6,000
11	141,000	20,000	11,000	8,000	10,000	39,000	25,000	13,000	7,000
12	46,000	1,000	3,000	3,000	6,000	26,000	4,000	1,000	10,000
Total	4,749,000	2,172,000	965,000	1,381,000	361,000	1,194,000	3,424,000	604,000	876,000



Dredged Material Volume /Area Versus Time for Areas with Varying Depths Below MLLW

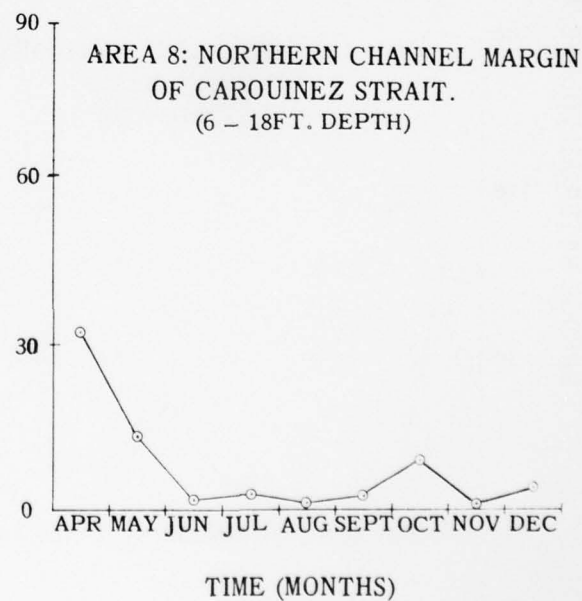
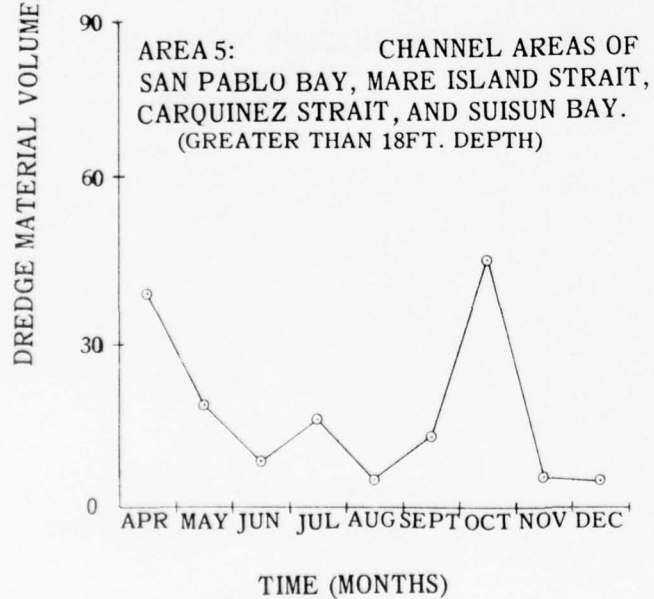
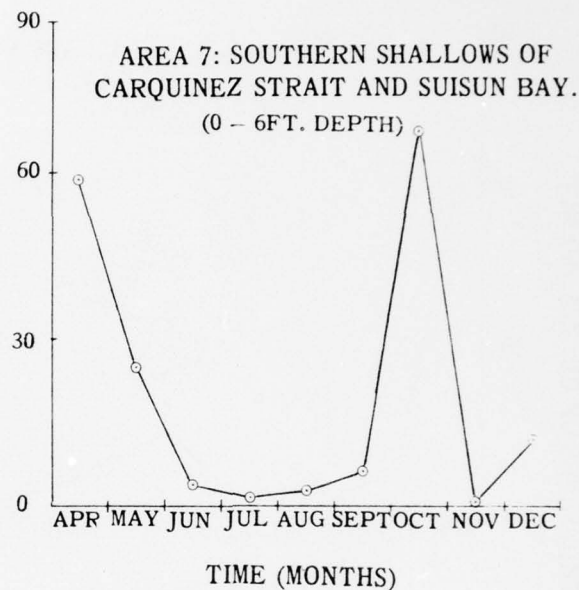
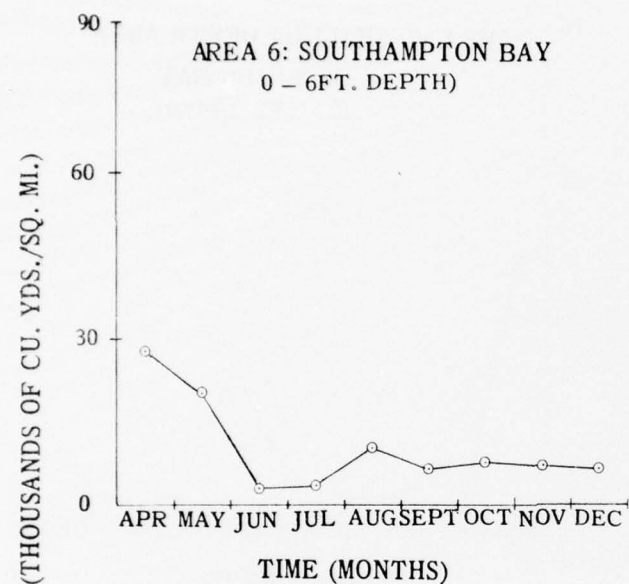


FIGURE 32 (CONTINUED)

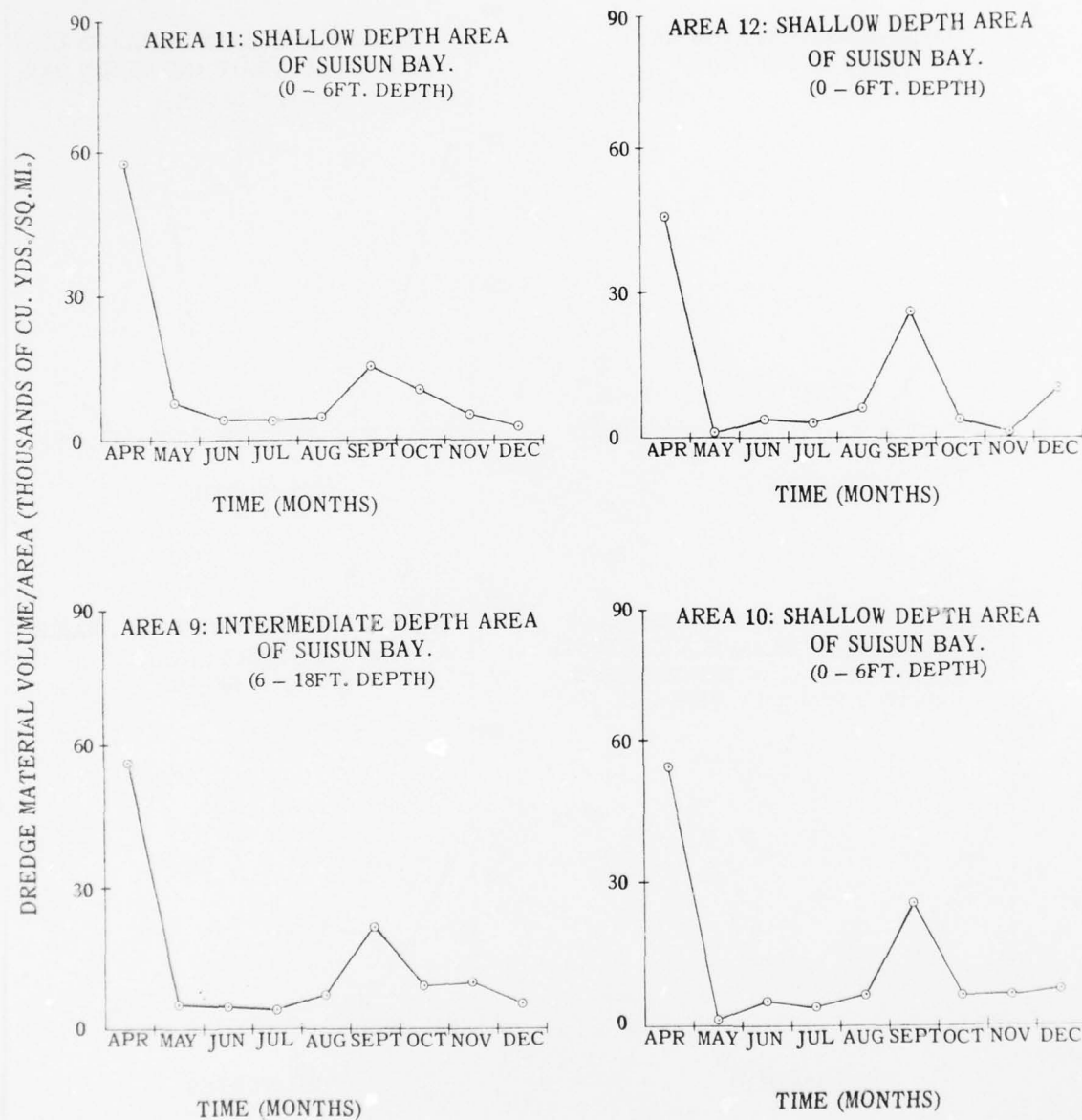


FIGURE 32 (CONTINUED)

In April, after cessation of dredging, the areas of highest concentration, varying from 50-70,000 yd<sup>3</sup>/sq. mi., of dredged material are the southern shallows of San Pablo Bay (Section 3), a shallow area on the southern side of Carquinez Strait extending into Suisun Bay (Section 7), and the shallows and an intermediate depth area of Suisun Bay (Sections 9,10,11, and 12). The initial areas of heaviest deposition of dredged sediments are the southern shallows of San Pablo Bay and almost the entire extent of Suisun Bay. All other parts of the study area show almost approximately the same volume/area value, approximately 30,000 yd<sup>3</sup>/sq. mi.

In May and June dredged sediments decreased throughout the study area. In Suisun Bay the large deposition values of April decreased drastically in May to a residual value, approximately 10,000 yd<sup>3</sup>/sq. mi., lasting through the August sampling period. Through July and August, the volume/area values remained at relatively low levels, except for the channels (Section 5) and the northern San Pablo Bay shallows (Section 1) during July. For these two areas, there was an increase in July to approximately the same values found in May. The increase in these two areas is significant since these two areas comprise approximately 67 percent of the study area.

The volume/area values for San Pablo Bay and the channels showed increases in September, and Suisun Bay (Sections 9,10,11, and 12) showed a significant increase from the August sampling. For Suisun Bay the values in September, prior to the dredging of the Mare Island channel, were the highest, with the exception of the values in April, for the entire study period.

During October a small area of shallows on the southern side of Carquinez Strait (Section 7), the channels (Section 5), the northern and southern margins of the channels in San Pablo Bay (Sections 2 and 4), and the southern shallows of San Pablo Bay (Section 3), experienced dramatic increases in their volume/area values. In all of these areas the volume/area values were higher than those in April after release of the tagged sediments. The values for Suisun Bay dropped back to similar levels seen in the May-August sampling periods.

In November and December, all Sections, except Section 1 and 7, show relatively small volume/area values.

The percentage distribution of dredged sediments for the three depth areas is shown in Table 7. In attempting to see any general trends in the distribution of dredged sediments, the percent of the study area covered by each depth range should be considered and is given as follows:

<u>Depth Range</u>	<u>Percent of Study Area</u>
0-6 ft	59.5
6-18 ft	18.3
>18 ft	22.2

The data in Table 7 shows that initially, in April, the largest percentage of dredged material was located in the shallow areas. It is interesting to note that the distribution of sediments by percentage in May is very close to the percentage of the study area covered by each depth range. In June there is a distinct shift from May in the percent material in the shallows to the channel margins. The distribution for July shows an increase over June in the shallows, an increase in material in the channels, and a significant decrease of material in the channel margins. The pattern of distribution from April to July may well be a pattern where dredged material is widely dispersed over the study area with sediment showing initial transport to the large expanse of shallows, recirculation and distribution (influenced by tides, wind, currents, climatic conditions, etc.) to the channel margins and channels with subsequent transport towards the ocean. This pattern is seen again from August through October and the beginning of another cycle in November and December. Table 7 shows the dynamic character of sediment movement and the assimilation of the dredged sediments into the system.

TABLE 7

Distribution (Percentage) of Dredged Material for  
Three Water Depth Ranges By Sampling Period

<u>Sampling Period</u>	<u>Depth Ranges</u>		
	<u>0-6 feet</u>	<u>6-18 feet</u>	<u>&gt; 18 feet</u>
April	63.2 <sup>1/</sup>	15.9	20.9
May	59.5	19.1	21.4
June	47.6	31.1	21.3
July	57.1	13.7	29.2
August	57.1	22.2	20.7
September	47.2	26.1	26.7
October	46.3	21.4	32.3
November	51.3	25.5	23.2
December	76.2	10.4	13.4

<sup>1/</sup> Percentages calculated from volume totals in Inclosure 3.

Dredged Sediment Movement to Central and South San Francisco Bay. Data analysis from stations sampled in Central and South Bays from September to December 1974 is contained in Inclosure 2. The data indicates that tagged sediments were found in low concentrations at several stations. The stations of heaviest concentration were located just north of the Richmond-San Rafael Bridge (4.38%), west of the island of Alameda (3.52%), and the Emeryville flats (2.41%). Minor amounts were found in the Richmond Harbor channel, the vicinity of the Berkeley pier, the Oakland Outer Harbor channel, east of the San Francisco airport (sta. 142), and Islais Creek along the San Francisco waterfront. The data verifies that dredged sediments were moving out of the study area into Central and South Bay, and that movement was occurring prior to September 1974. No estimate of quantity or arrival time is possible from the limited data available.

Vertical Distribution of Dredged Sediments. The vertical distribution of dredged sediments reflects the layering and mixing of these sediments with other sediments in the study area. Inclosure 2 shows that analysis of various samples was accomplished for sample increments at depths greater than 9 inches. The deepest layer analyzed was Layer H which extended to a depth of 29 inches. Tagged sediments were located in Layer H.

Finding tagged sediments at depths of approximately 2.5 feet indicates that sediments are being mixed either during deposition or after deposition. From the sample data, vertical mixing of sediments did occur in the "active" zone. The "active" zone is that group of sediments which appeared to be recently deposited and could be easily resuspended, while the "inactive" zone is a visual interpretation of those sediments which have not recently moved. In most instances the "active" zone included the top 9 inches of sediments.

The data for Stations 1, 3, and 64 in Mare Island Strait show significant quantities of tagged sediments below Layer C. This would be expected since shoaling of the dredged channel is occurring, and deposition is probably occurring in successive layers. Deposition in the Strait with little vertical mixing of sediments is indicated in holes 1 and 3 by the high percent dredged material values in some layers while other layers in close proximity have low or zero values, such as the value of 20% in hole 3, Layer G, which is in the "inactive" zone. Further indication of layering of deposited sediments is shown in the profile sampling data taken in late August 1974 in Mare Island Strait where layering is indicated to depths of 5 feet.

Tagged sediments at depths greater than 9 inches and in the "inactive" zone were found in the San Pablo Bay shallows and channel area and the channel area of Carquinez Strait, and relatively little tagged material was found below 9 inches in Suisun Bay.

Another factor which provides data on the vertical distribution of dredged sediments in terms of deposition and erosion is the sampling depth data given in Inclosure 2. However, as mentioned earlier, the problem with accurate horizontal location of the sampling boat and the vertical control reference limits deductions from this data.

Many of the stations in shallow areas, however, were staked, establishing a fixed sampling point. Station number 104 in northern San Pablo Bay is used as an example. Figure 33 is a plot of percent dredged material and depth of water below mean lower low water versus time. Straight lines are used to connect the various points, since the actual variation between sampling periods is not known. As can be seen in Figure 33, no correlation of changes in sample depth with changes in percent dredged material is apparent.

The lack of any correlation is expected because of the uneven and changing bottom configuration, dynamics of sediment movement and the fact that the dredged sediments are not the sole source of sediments for the system.

An important conclusion can be drawn from the lack of correlation of depth changes with changes in percent dredged material. Changes in the value of percent dredged material at sampling locations are indicative of the forces circulating and mixing the dredged sediments with other sediments in or entering the study area and do not represent shoaling.

Graphical Displays. Graphical displays of the percent dredged material data, similar to those in Figures 18-28, were produced for layers A, B, and C for each sampling period. These displays are contained in Inclosure 4 and will be used in the following discussions.

In early March the highest percentages of dredged material were found in layer A. In late March generally higher percentages of dredged sediment were found in layers B and C.

Comparison of the displays for layer A for early and late March show a similarity in the concentration of higher percentages of dredged sediment in the westerly reach of Pinole Shoal Channel and around Pinole Point. A large portion of the dredged sediments tended to initially move westerly through the natural and maintained channel seaward towards the Golden Gate. Comparison of the layer B and C displays shows the sediments to be dispersed from the areas of high concentration near the disposal site in early March and to concentrate in an area northwest of Dike No. 12 and the northern shallows of San Pablo Bay in late March.

Covering and uncovering of sampled sediments versus time for sample hole 104 (Northern San Pablo Bay Flats, staked)

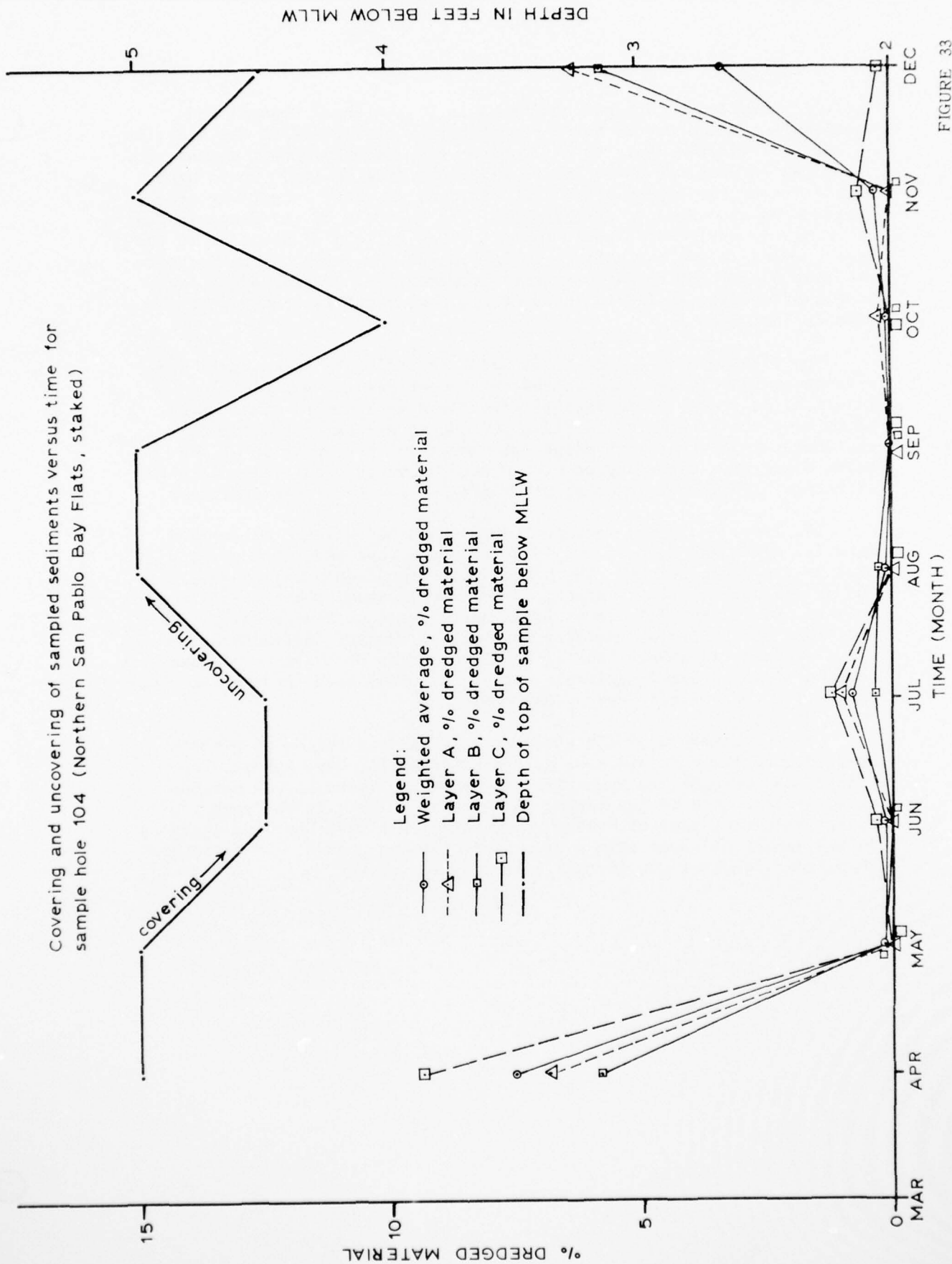


FIGURE 33

The concentration of dredged sediments in Pinole Shoal Channel and northern San Pablo Bay in March can partly be attributed to the location of the salt water wedge. In early March the westerly extent of the wedge was located somewhere in San Pablo Bay (Figure 14). On 21 March with a freshwater inflow of 65,000 cfs, the westerly extent was at the western end of Carquinez Strait (19). The location of the wedge in San Pablo Bay in early March would cause a large buildup of sediment in the area sampled in San Pablo Bay. In late March the shift of the wedge to the east would tend to cause greater dispersal and corresponding lower levels of dredged sediments in San Pablo Bay, which is observed in the maps in Inclosure 4.

The displays for layers A, B, and C in Inclosure 4 for April indicate approximately the same values of percent dredged material for layers A, B, and C. This data is summarized in Table 8. This trend, along with the late March sampling period, shows that the dredged sediments, concurrent with dispersal throughout the study area, are being mixed to a large degree with other sediments, especially with the extremely high inflow of fresh water (Figure 14) and fresh sediments.

The layer A display for April shows high percentages of dredged material north and east of Pinole Point and at the edge of the study area at San Pablo Strait. The high values came from sampling hole no. 105 at the edge (< 18 ft. depth) of the Pinole Shoal Channel and from hole no. 95 in the shallows (< 3 ft. depth) west of Pinole Point. This indicates a significant westerly movement of dredged sediments at the water-sediment interface, and is an illustration of movement of some portion of the dredged sediments out of the study area through the study boundary at the western end of San Pablo Bay.

Percent coverage of the study area by various ranges of percent dredged material for layers A, B, and C for April, May, August, September, and October are summarized in Table 8. There is one obvious trend demonstrated in the table. A decrease is seen in the number of higher values of percent dredged material with a corresponding increase in the number of lower values from April through August. In September this trend reverses and further increases in October.

Table 8  
COVERAGE OF THE STUDY AREA BY VALUES  
OF % DREDGED MATERIAL

Layer	% Dredged Material		
	0-0.5	0.5-4	4-8
		APRIL	> 8
A	26.4 <sup>1/</sup>	51.6	15.4
B	25.0	45.6	18.5
C	29.7	40.6	19.8
		MAY	
A	42.3	48.4	7.2
B	36.5	53.1	6.2
C	30.9	56.7	7.2
		AUGUST	
A	78.8	20.2	1.0
B	82.8	17.2	0
C	83.5	16.5	0
		SEPTEMBER	
A	74.5	23.5	0
B	71.7	24.2	1.1
C	82.6	13.3	0
		OCTOBER	
A	56.6	29.3	3.0
B	62.6	20.2	7.1
C	60.6	21.2	10.1

<sup>1/</sup> Percent of study area containing % dredged material values within the specified range.

In April extremely high freshwater inflow (Figure 14) brought fresh sediments to the study area and caused dilution of the circulating and deposited dredged sediments. From May through October a residual level of freshwater inflow from 20 to 40 thousand cfs was estimated. The changes observed in Table 8, however, do not generally correlate with changes in freshwater inflow.

A general correlation with the changes observed in Table 8 is evident with the wind data in Figures 15 and 16. From April through August the recorded winds result from a general westerly flow of air over the Bay area. In September and October the westerly flows are balanced by northerly, southerly, and easterly flows. The wind speeds in September and October show a significant reduction over those in the summer months. Dispersion and circulation of dredged sediments by the summer wind conditions results in increasingly low levels of dredged sediments. The changing of wind conditions in September and October appears to recirculate higher concentrations of dredged sediments probably from the northern and eastern shallows of San Pablo Bay and Suisun Bay.

Dredged Sediment Volumes. Figure 34 is a plot of the total volume of dredged material calculated for each sampling period versus time along with plots of the dredged material/inch calculated for layers A,B, and C. The per inch plots makes layers B and C comparable with layer A. For clarity, the various sampling period volumes are connected with straight lines, since the actual variation between sampling periods is not known. The March sampling period has been excluded due to its limited sampling area.

The plots of dredged material/inch for layers A,B, and C (Figure 34) show interesting comparisons. In April, just after the completion of dredging, layer A has the largest volume/inch. In May and June, layer C has the largest volume which indicates same covering of dredged sediments with other sediments. For August, September, and October, layer B has consistently the largest volume followed by layer A and C, suggesting that the dredging of the Mare Island channel from 20 September to 30 October was not the primary cause of the increase of percent dredged material found in October for the entire study area. The effect of the redredging of the Mare Island channel can be seen in November, where layer A has a much larger volume/inch than either layer B or C.

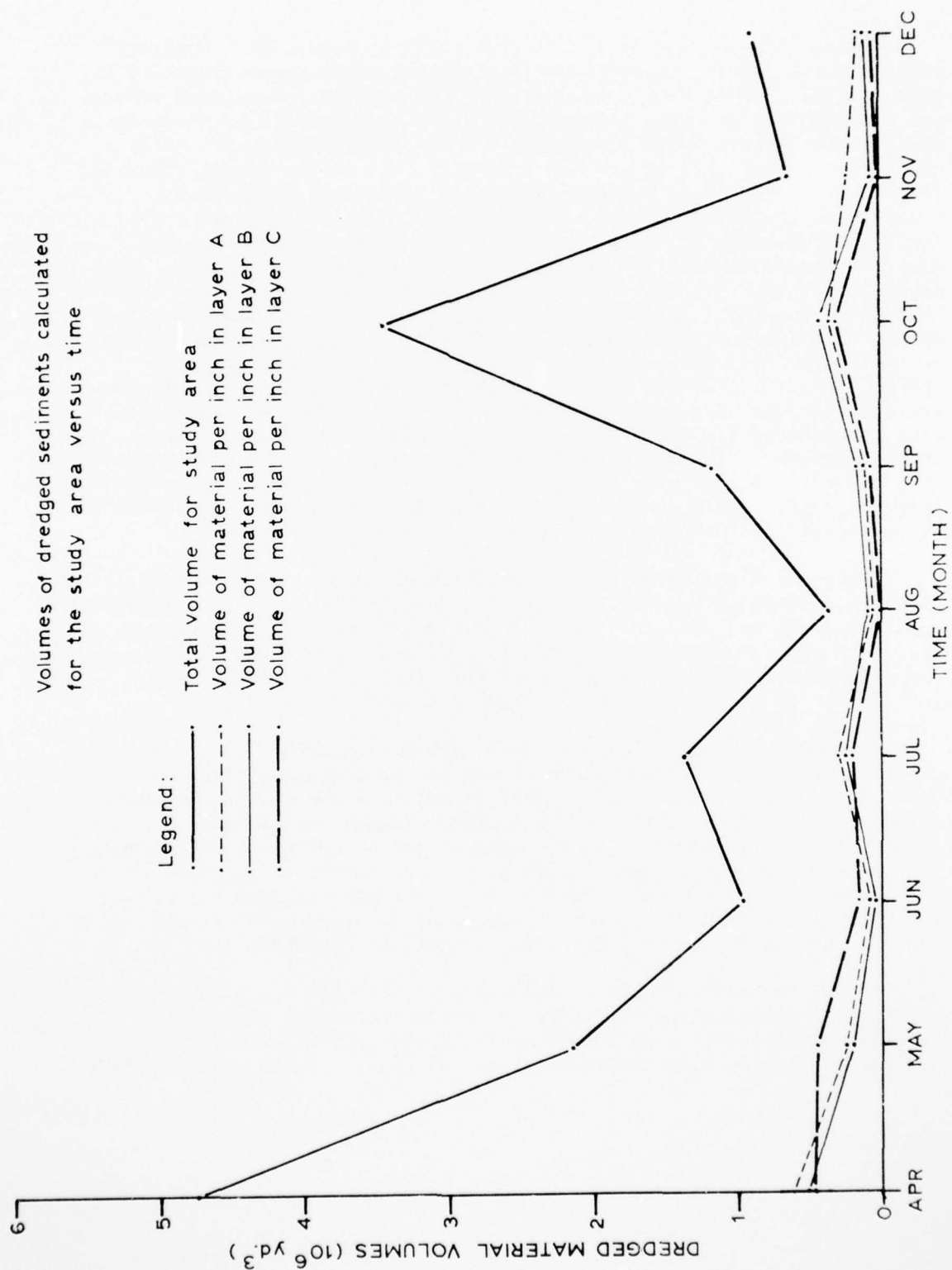


FIGURE 34

Figures 35, 36, and 37 are similar plots to Figure 34. However, these figures display volume/inch data for the three depth areas 0-6 ft, 6-18 ft, and > 18 ft MLLW. As expected, the highest volume/inch values are from the 0-6 ft areas because this depth range covers 59.5 percent of the study area. Again looking at October and November, the effects of the second dredging period are initially felt in the deeper channels (Figure 37, layer A) in October, with some subsequent movement in November to shallow areas (Figure 35 and 36). Figure 38 shows a plot for the three areas of the weighted average of volume/inch for each sampling period divided by the square miles occupied by the area. This figure shows the relative difference in the tendency for dredged material to be concentrated at various depths. In April and May the effect of the high freshwater inflow on distributing the dredged material can be seen. In June, July, August, and September the distribution of dredged material over the various areas is fairly uniform. In October the distribution of dredged sediments is much less uniform with a greater tendency for the sediments to be found in the channels and channel margins. The factor which may have caused this change in trend in October is the dredging of previously dredged sediments in Mare Island Strait. The effect of the dredging in Mare Island Strait will be discussed in the following section.

Figure 38 illustrates the distribution of dredged sediments by floodflows in April and May, circulation and distribution of sediments occurring with the summer climatic conditions from June to September, a redistribution of sediments by changing climatic conditions in October, and significant movement of sediments out of the study area in the latter part of October (prior to November sampling).

Movement of Dredged Sediment into Mare Island Strait. To determine the efficiency of the disposal operation at the Carquinez site for the Mare Island channel dredging project, an estimate for the percentage of disposed material returning to the dredged channel must be made. A return of dredged sediments to the channel can occur in one of two ways; the sediment can return immediately after disposal on a floodtide or by the circulation of suspended dredged sediments carried into the Strait after deposition and subsequent resuspension in other parts of the system, such as Suisun Bay, Carquinez Strait, or San Pablo Bay.

Use of the percent dredged sediment for only the top 9 inches of sediments for estimating the return of sediments to the channel is somewhat unrealistic since shoaling of the channel, at certain places, can exceed five feet. A better estimate of return to the channel can be

VOLUME /INCH OF DREDGED MATERIAL  
CALCULATED FOR AREAS OF WATER DEPTH OF 0 - 6 FT MLLW

LEGEND:

- VOLUME /INCH IN LAYER A
- VOLUME /INCH IN LAYER B
- VOLUME /INCH IN LAYER C

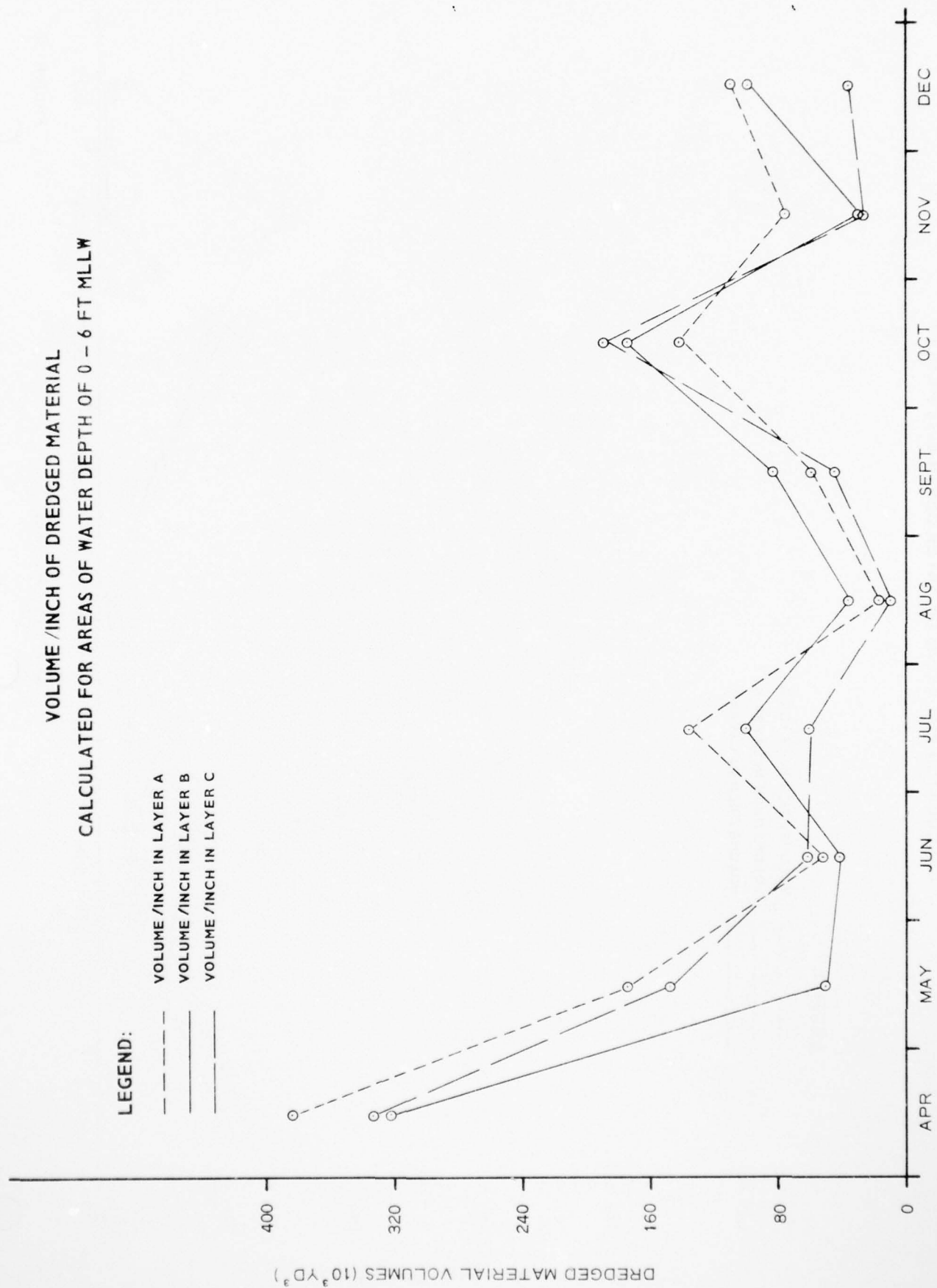


FIGURE 35

VOLUME /INCH OF DREDGED MATERIAL  
CALCULATED FOR AREAS OF WATER DEPTH 6-18 FT MLLW

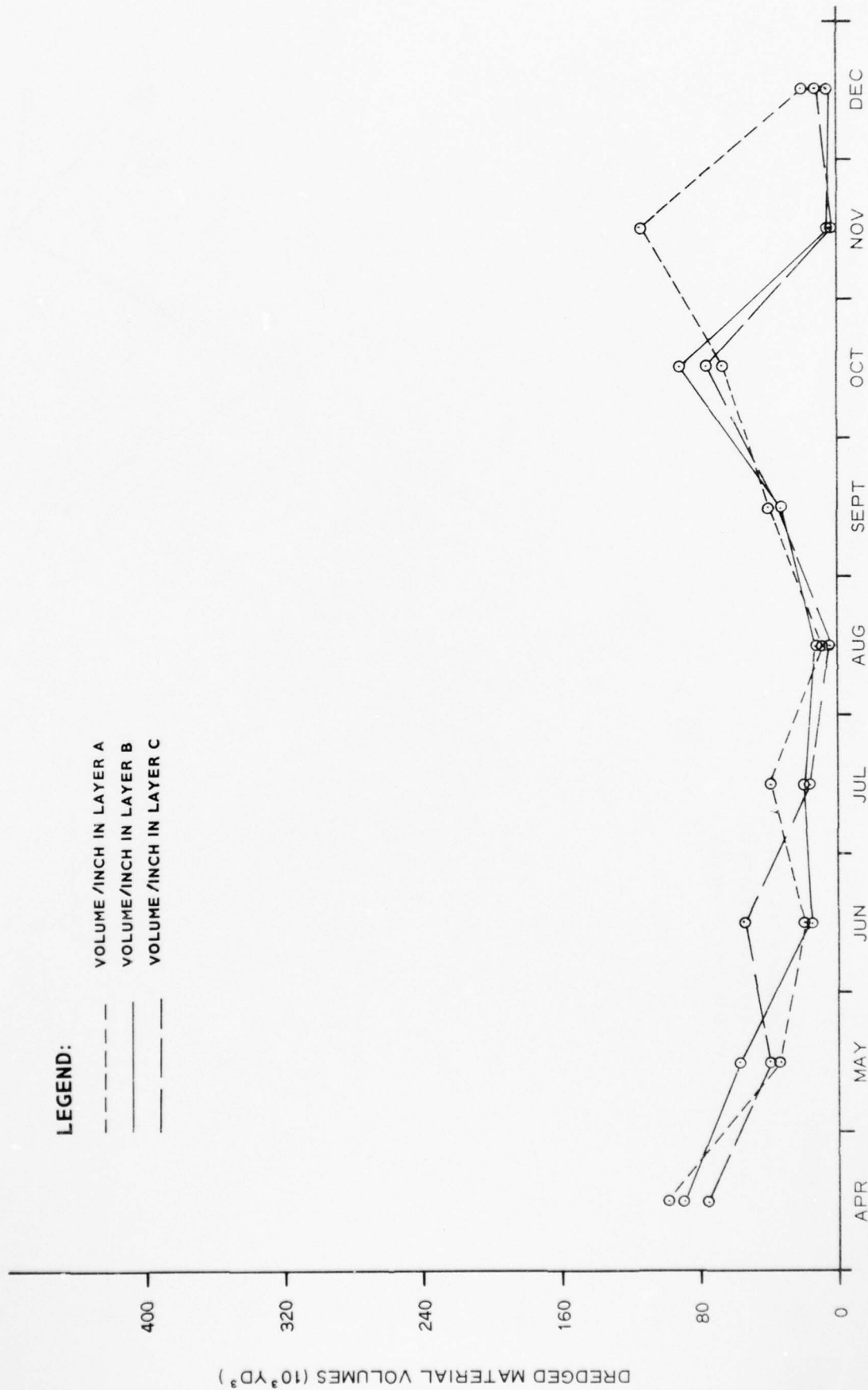


FIGURE 36

VOLUME /INCH OF DREDGED MATERIAL  
CALCULATED FOR AREAS WATER DEPTH > 18 FT. MLLW

LEGEND:

- VOLUME /INCH IN LAYER A
- VOLUME /INCH IN LAYER B
- - - VOLUME /INCH IN LAYER C

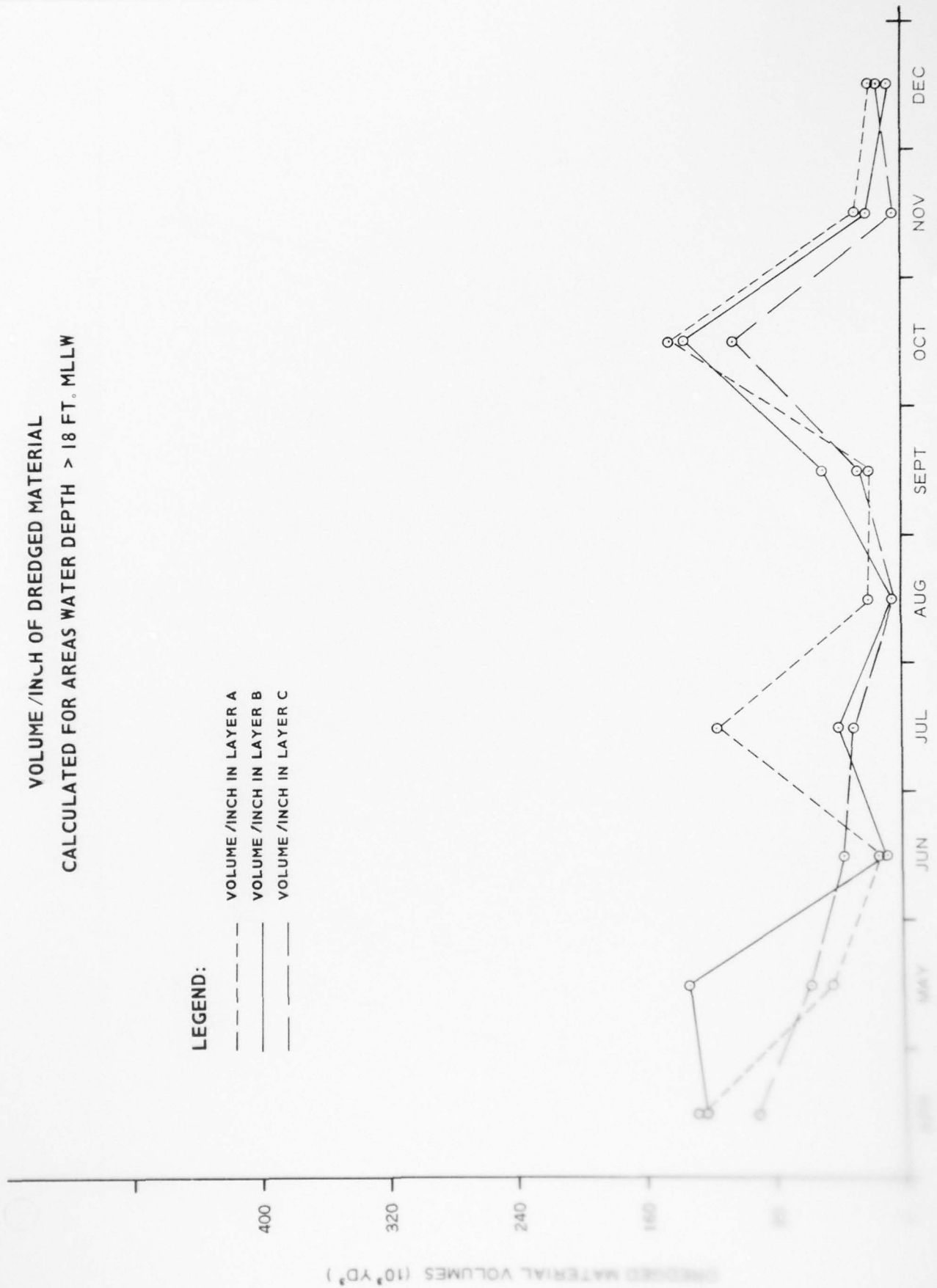


FIGURE 37

SAMPLING PERIOD

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DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY, APPENDIX --ETC(U)  
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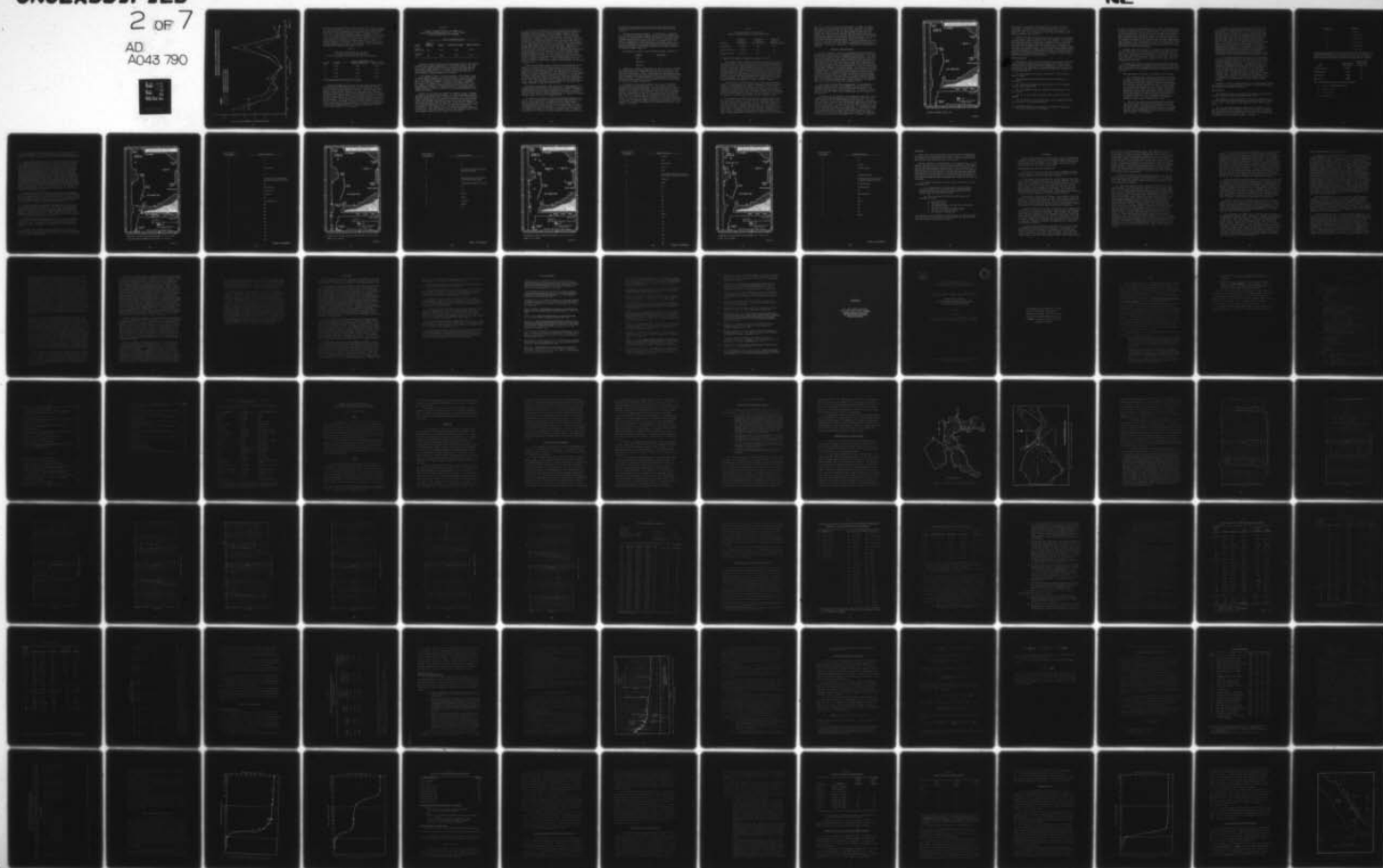
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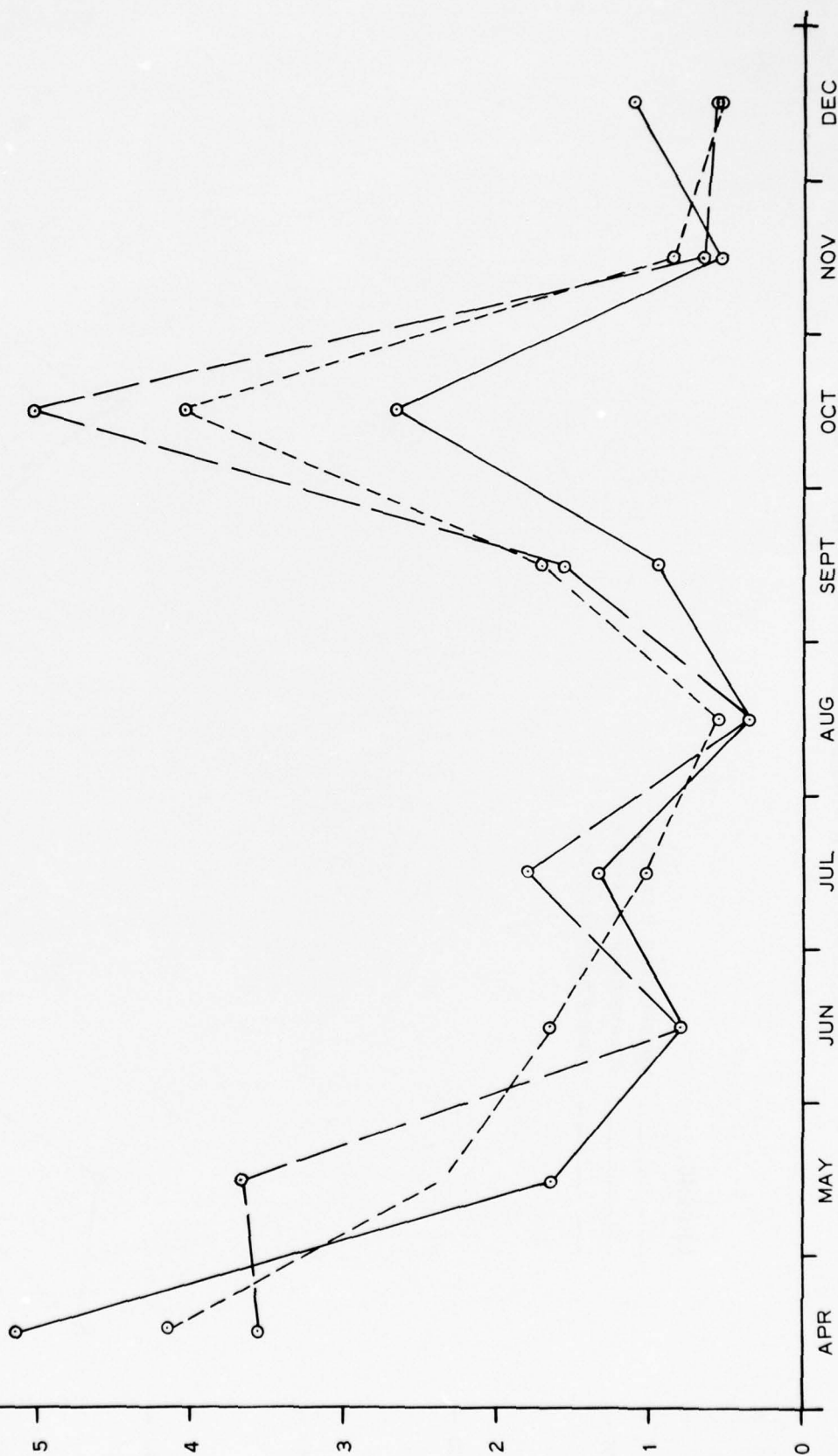


VOLUME/INCH - MI OF DREDGED MATERIAL CALCULATED  
FOR AREAS OF WATER DEPTH 0-6FT, 6-18 FT, > 18 FT MLLW

LEGEND:

- VOLUME /IN-MI<sup>2</sup> FOR 0-6 FT DEPTH
- - - VOLUME /IN-MI<sup>2</sup> FOR 6-18 FT DEPTH
- VOLUME /IN-MI<sup>2</sup> FOR > 18 FT DEPTH

DREDGED MATERIAL VOLUMES (10<sup>3</sup> YD<sup>3</sup> / IN - MI<sup>2</sup>)



SAMPLING PERIOD

FIGURE 38

made using the data (Inclosure 2) from sampling in the Strait to depths of 5 feet in late August. Table 9 shows an average, standard deviation and range for percent dredged material found in Layers B,C,D, and E. Layers B, C, D and E each represent a layer of sediments 15 inches thick. The total depth of sampled sediments, including all four layers, is 5 feet. Table 9 shows the average percent dredged material in each of the layers varies from 0.4 to 2.4% with the highest value of 6.9% found in layer E. This special sampling indicates a low return of dredged sediments to the channel. The estimate of return may be low in that the sampling may not have been deep enough. This is indicated by the highest percentages being found in layer E.

TABLE 9

Average, Standard Deviation, and Range  
for Values of Percent Dredged Material  
from Profile Samples for Layers B,C,D, and E in Inclosure 2

<u>Layer</u> <sup>1/</sup>	<u>Percent Dredged Material</u>		
	<u>Average</u>	<u>Standard Deviation</u>	<u>Range of Value</u>
B	0.35	0.81	0-3.5
C	0.63	1.06	0-4.5
D	0.45	0.57	0-1.3
E	2.42	2.37	0.7-6.9

<sup>1/</sup> The thickness of each layer is 15 inches.

Samples of dredged material taken from the dredge hoppers during the February-March dredging (Inclosure 2) and analyzed for iridium content provide another indication of return. The samples were taken randomly during dredging operations from late February through late March at varying sections (Figure 12) in the Strait area. Analysis of the hopper sample data is given in Table 10 where the average, standard deviation, and a range of values for two periods are shown. The first period, 23 February-29 March, includes all of the hopper samples taken during dredging. The second period, 15-29 March, presents the data for the last portion of dredging. The data for late March was chosen for analysis since disposal operations had been occurring for approximately a month and the sampling during this period encompassed all of the various areas (Figure 12) of the Strait.

Table 10

Average, Standard Deviation, and Range for  
Values of Percent Dredged Material in Hopper Samples  
for the February-March 1974 Dredging

<u>Period</u>	<u>Number of Samples</u>	<u>Percent Dredged Material</u>		
		<u>Average</u>	<u>Standard Deviation</u>	<u>Range of Values</u>
23 Feb - 29 Mar 1974	56	10.0	11.82	0-49.9
15-29 Mar 1974	24	10.5	9.33	0-27.0

The data in Table 10 indicates that approximately 10% of the dredged sediments were returning immediately to the dredged channel. The data for the total sampling period and the late March period have about the same average value; however, the standard deviation and range for the total period is higher than for late March, which indicates a more uniform mixing of tagged sediments in late March.

A 10% immediate return of dredged sediments to the channel, based on hopper samples, appears to be a valid estimate. Prior to the dredging of the channel in September and October, other dredged sediments, due to recirculation processes, returned to the channel. Sediments returning to the channel prior to dredging in September-October would not return in a greater concentration than exists in the study area, approximately 2-4 percent. A maximum estimate of percentage return of dredged sediments to Mare Island Strait for subsequent redredging would approach 15 percent.

Support of the 10 percent estimate for immediate return of dredged sediments to the channel is provided by the study of sediment movements into Mare Island Strait using a radioactive tracer (15). The field test using the radioactive tracer simulated the dumping of one hopper dredge load at the Carquinez site when the lower water column had started to flood into the Strait, and the upper water column was still ebbing. The flow condition selected for the field test gave the most probable return of sediments to Mare Island Strait. The field study resulted in a detection of 5 to 15 percent of radioactive-labeled sediments deposited in the Strait. Thus, the estimate of 10 percent immediate return to the Strait agrees closely with the radioactive tracer data.

The results of shoaling tests of Mare Island Strait, reported in Reference 2, using the San Francisco Bay Model also disclosed that a relatively small percentage of released dredged sediments were re-entering the Strait immediately after disposal. Tests on the model resulted in 5.5 percent of the released material returning to Mare Island Strait. However, the disposal operation in the model tests were conducted at the Carquinez disposal site on the ebbing tide and just east of the entrance to the Strait on a flooding tide. The difference in the disposal operations does not provide direct comparison of the 5.5 percent model result with the 10 percent prototype. However, on a qualitative basis, both show relatively small percentages of the released material re-entering the Strait. An additional difference in the prototype tracing test and the model test was the freshwater inflow during disposal operations. The model tests were run with a Delta freshwater inflow of 16,000 cfs. The freshwater inflow during the disposal operations in the prototype tests varied from a low of 45,000 cfs to a maximum of 140,000 cfs. A significant differences in the location of the salt water wedge probably occurred between the model and prototype tests.

Bureau of Reclamation studies (18) show that the location of the wedge, for the model and prototype tests were quite different, and indicate the fluctuation of the wedge during the course of the tracing operations from March-December 1974. The location of the saltwater wedge and associated high suspended solids determines the flood currents present to transport sediments into Mare Island Strait. The location of the wedge in Carquinez Strait in March 1974, during actual disposal operations, would trap sediments in Carquinez Strait for longer periods of time than if the zone were located in Suisun Bay (as in the model test). This longer detention rate would induce a higher percentage of dredged sediments to enter Mare Island Strait.

Additional hopper samples taken during the October-November 1975 dredging (Table 3) indicate a small percentage of sediments dredged in February-March 1974 were still circulating in the Strait. The data indicates that previously dredged sediments were found in the Strait a year and a half after the initial dredging and two subsequent dredgings, showing a decay in the rate of sediment return.

In conclusion, results from the monthly sediment sampling at locations in Mare Island Strait, sediment sampling along profiles of the Strait in late August 1974, and samples from the dredge hopper in February-March 1974 indicate a relatively low percentage, ~10%, is returning immediately after disposal to the dredge channel. Based on the dispersion of sediments throughout the system and the decay rate of sediments returning to the channel, a maximum return is estimated to be about 15%. The rate of return estimated by shoaling tests on the

Bay Model and by radioactive tracing tests provide qualitative and quantitative agreement with the rate found in the iridium tracing operation.

Shoaling in Small-Craft Harbors. In recent years, a contention that the disposal of dredged sediments at the Carquinez disposal site increased the shoaling rate of small-craft harbors on the south side of Carquinez Strait and just west of Davis Point has created controversy over the designation of the Carquinez site as a disposal site. To provide a perspective to this controversy, the marinas located in this area were investigated for shoaling potential using deposition data previously discussed. The marinas considered are the Rodeo, Dowrelío, and Martínez marinas (Figure 2).

The marinas are located in the following sections of Figure 31:

<u>Marina</u>	<u>Section No.</u>
Rodeo	3
Dowrelío's	5
Martínez	7

Inspection of Figure 32 shows that, for each of the three marinas, the sampling period of maximum deposition in the top 9 inches of sediments was October 1974. Figure 32 also shows that these marinas are located in high deposition areas, indicated by the high deposition/area after dredging in April and the high concentration of sediments in these areas in October. A further indication of the tendency for sediment deposition in these areas is that the marinas are all located in areas of naturally occurring shallow water.

An estimate of the shoaling potential for each of the marinas during October is presented in Table 11. The estimated volume of shoaling was derived by multiplying a corrected material/area value in Figure 32 for October by the surface area of the particular marinas. Because of the inherent over-estimation of the total volume of dredged material accounted for in Table 5, the corrected volumes in Table 11 were obtained by adjusting the total dredged material calculated for April (used as a base for comparison purposes) to the actual dredged volume of 1.6 million cubic yards. The depth of shoaling was calculated by spreading the estimated shoaling volume over the surface area of the marinas. The material was assumed to be deposited uniformly with a wet density of 1.3 g/cc.

Table 11  
Shoaling Potential for Small-Craft  
Harbors in Carquinez Strait, April-December 1974

<u>Location</u>	<u>Estimated Surface Area (Mi.<sup>2</sup>)</u>	<u>Estimated Shoaling, Oct. 1974 (yd<sup>3</sup>)</u>	<u>Estimated Depth of Shoaling (in.)<sup>1/</sup></u>
Rodeo Marina	12.2x10 <sup>-3</sup>	350	0.3
Dowrelío's Marina	6.3x10 <sup>-3</sup>	95	0.2
Martínez Marina	34.1x10 <sup>-3</sup>	805	0.3

<sup>1/</sup> Based on wet density of deposited sediments of 1.3 g/cc.

The estimated depth of shoaling in the three marinas for October is less than an inch. If depths were calculated for each sampling period, the deposition for the total 9 months would also be much less than an inch for each marina. This estimate does not take into account possible erosion of deposited sediments in the marinas due to tidal action and prop wash from small craft traversing the marina or the actual condition (dredged depths) of the marina. If the marina had been recently dredged, the rate of shoaling in the marina would be higher than if it had reached an equilibrium depth (sediments being resuspended at the same rate as shoaling). The estimate in Table 11 assumes that all dredged sediments entering the marina never leave, except by dredging.

The high rate of shoaling experienced by these marinas would not appear to be predicated on the volume or frequency of dredged sediment released at the Carquinez site because, once released, the dredged sediments are recirculated by estuarine processes. Rather, the rate of shoaling is dependent on the total volume of sediments in circulation within Suisun and San Pablo Bays, the difference between the equilibrium and actual water depths in the marina, and the location of the marinas in relation to the fluctuating location of the salt-water wedge.

If the marina has recently been dredged to increase water depths, the estuary will attempt to re-establish the equilibrium depth by depositing sediments, from any source. As the equilibrium depth is approached, the rate of shoaling will decrease. The close proximity of the salt-water wedge or mixing region of fresh and salt water has a great effect on the shoaling of the three marinas. During high fresh-water inflow, the wedge is located in an area which encompasses the three marinas. Continuing recirculation of large quantities of sediments in the wedge makes the potential for shoaling in this region very

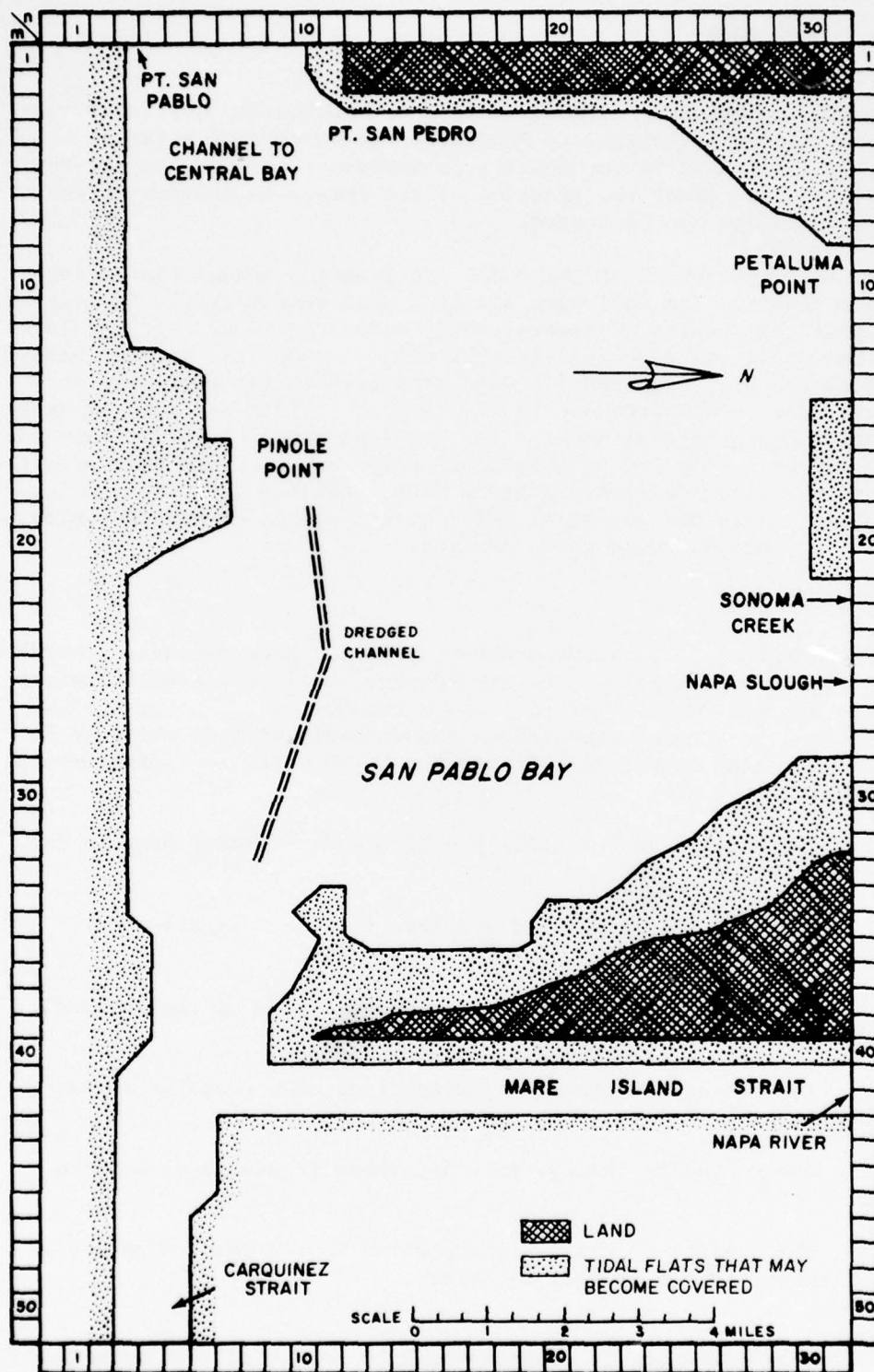
high (10). In the relatively low inflow months of summer, the wedge moves eastward into Suisun Bay and the Delta. Sediments suspended in the shallows of San Pablo Bay are carried upstream, near the channel bottoms, by flood tides. The net water movement upstream near the channel bed carries sediments eastward into the mixing region where the sediments mix upward with the westerly flowing fresh water and increases the suspended sediment concentration of the surface waters. The sediments then flow back downstream and redeposit in shallow areas or settle to lower depths and recirculate. These three marinas are located in areas of shallow water either within or downstream of the mixing region for a large part of each year. A high rate of shoaling would be expected.

#### NUMERICAL SIMULATION MODEL

Dr. B. H. Johnson of the U.S. Army Engineer Waterways Experiment Station (WES) investigated (20) mathematical models which could be used to describe the physical fate of disposed dredged material. His investigation disclosed that "very little mathematical modeling of the physical fate of dredged material disposed of in an aquatic environment has been undertaken." He found that the only significant modeling effort was by Koh and Chang (21), which allowed prediction of dispersion and settling of material in the ocean from disposal, either by instantaneous bottom dump or pumping, from a moving barge. For estuarine and riverine environments, he found no sediment transport models capable of tracing dredged sediments. In June 1973 the San Francisco District entered into a contract with the Stanford Research Institute (SRI) of Menlo Park, California for development of a numerical simulation model of dredged material dispersion in the study area. The contract included development of the numerical simulation by incorporating a material transport model into an existing estuary model, limited testing of the numerical model, and a report to document the contractual effort.

This section will describe the development of a two-dimensional numerical simulation model, called DREGSIM, for the dispersion of dredged material disposed in the Material Release study area. The extent of the model area is shown in Figure 39. The model is broken down into grid cells which can be located using the  $n/m$  notation shown in Figure 39.

The purpose for development of the mathematical model was to have a capability for studying dredge material dispersion in the study area after completion of the tracing program in the prototype. Since the tracing program in the prototype was conducted under specific conditions of river inflow, wind, etc. that occurred from February-March 1974 and disposal of material at one site, the results from the prototype would only be applicable for that set of conditions. If a mathematical model could be developed which could reasonably duplicate the results of the tracing program in the prototype, then material dispersion could be evaluated for varying site conditions and for disposal of dredged material at sites other than the Carquinez site. The primary advantage in



Numerical model study area

FIGURE 39

working with a mathematical model, which can reasonably duplicate conditions in the prototype, to determine the outcome of a set of prescribed conditions is the ability to reproduce the results for any number of tests. Also, the reaction of the system to changes in the various conditions can be tested.

The SRI development of the model and a user's manual are Inclosure 5 to this report. The following sections will summarize the SRI report and discuss the results of several tests using the model. It should be noted that qualitative or quantitative comparison of the various SRI tests with the prototype tracing data presented in the preceding sections will not be compared due to the limited testing and lack of verification of the numerical model. The development of the numerical model is reported primarily for informational purposes. Further work with the model and verification with prototype data, possibly from the tracing program, is considered essential prior to acceptance of model results as representing conditions in the prototype.

#### MODEL DESCRIPTION

The numerical model incorporates the basic three-dimensional hydrodynamic equations describing the time-dependent fluid motion. These equations are too complex for rigorous mathematical treatment; hence, the equations are transformed into a two-dimensional form suitable for solution on a high speed digital computer by appropriate approximation. The approximations are:

- (1) The estuary is essentially well-mixed.<sup>1/</sup> Water density is always constant.
- (2) Vertical velocities and vertical fluid acceleration are negligible.
- (3) Tidal action results from the oceanic tide at the seaward boundary at San Pablo Strait.
- (4) The freshwater flows are unimportant when compared to the tidal flows.
- (5) Due to the freshwater inflows, there is always a net flow seaward.
- (6) The density of the receiving water is not changed appreciably by the disposal of the dredged materials.

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<sup>1/</sup> A well-mixed estuary is characterized by essentially uniform salinity from the surface to the bottom.

The first, second, and sixth assumptions are simplifications which are necessary to keep the model to a manageable size. The third assumption is valid for San Pablo Bay since it is relatively small and tidal differences insignificant. The first and fourth assumptions are valid only under conditions of low fresh-water inflow. The high fresh water inflows during the winter and spring months exert a greater influence on the movement of sediment in the study area than the model would predict, and the location of the mixing region for salt and fresh waters, during high freshwater inflow, is located in portions of the model area. The hydrodynamic equations also include the effects of wind, bottom stress, tidal action, and turbulent diffusion.

The model allows the introduction of individual dredged particles into the study area. The settling and movement of the particle in the estuary is a function of the hydrodynamics of the water body and the size, shape, and composition of the particle. The vertical velocity is from a description of the settling velocity by Murry (22). The horizontal velocity of the particle is assumed to be the same as the surrounding fluid velocity.

The model also includes a diffusion simulation which allows calculation of dredged material concentrations at each point in the study area. This calculation is accomplished using the general equation (23) for the transport of fine sediments based on the conservation of sediment mass.

The functioning of the model is described in the following:

(1) The hydrodynamic simulation calculates the velocity components and water surface elevations with respect to mean sea level on a horizontal, two-dimensional grid. The grid can account for arbitrary geometry in plan and variable depth. The velocities are depth averaged, so there is no resolution of a vertical velocity profile. The velocity field is generated using depth averaged equations of motion with boundary conditions of wind stress at the water surface, friction at the bottom, and open and closed bounds in the horizontal; open bounds include one ocean inlet with tidal rise and fall of the water surface, as well as landward openings with freshwater inflow. The program accounts for flooding and drying up of grid points to simulate tidal flats.

(2) The tracer particle simulation uses the calculated flow field to move tracer particles through the two dimensional flow field. The particles are assumed to move with the same horizontal velocities as water particles. The typical size of the non-dispersed particles found in the dredged material of Mare Island Strait is on the order of 20 microns (18) (1 micron =  $1 \times 10^{-6}$  meters).

(3) There are several restrictions on the tracer particle movements in the model which influence the validity of the results. The time required for a particle to reach its terminal settling velocity is less than a second, and, since the time steps in the model are several hundred seconds, the particles have in all cases reached their terminal velocity. Because it was assumed that the vertical fluid velocities were negligible and no vertical salinity gradient exists, there is no vertical force to resist particle settling. Thus, unless a correction factor is applied, the particles will always travel along the bottom. In addition, if a resuspension factor, based on local turbulence, is introduced, any disturbance will resuspend the particles, since the model includes no allowance for flocculation or interparticle forces while the particles are settling on the bottom. These restrictions must be considered when evaluating model results.

(4) The diffusion simulation solves the two dimensional advective diffusion equation for concentrations at grid points, using the calculated velocity field. The simulation accounts for two dimensional dispersion of a dynamically passive, conservative, dispersable substance. The assumption that the substance is dynamically passive means that the introduction of the substance into the flow field does not appreciably affect the magnitudes and directions of fluid velocities. No attempt is made to simulate the actual sediment loading in the study area. The disposed material is treated as a separate substance and is simulated for convection and diffusion. It is intended that this mean concentration simulation would give an indication of probable areas of initial dredged material movement.

The model is coded for implementation on a CDC 7600 computer system and has been run by the San Francisco District on the CDC 7600 system at the University of California, Berkeley.

#### INITIAL RESULTS

SRI conducted a series of simulation calculations with the model to determine if the model was giving reproducible results.

One simulation run was conducted in which iso-concentration contours were plotted for material disposed in Carquinez Strait at location  $n = 6$ ,  $m = 36$ . A discussion of this simulation can be found in Inclosure 1.

Four runs were made simulating tracer particle movements. These runs were carried out for 1,000 time steps (111.11 hours). During the test one new particle was introduced into the study area at a disposal site every two hours of simulation time. For all of the tests the first six particles were initially positioned as follows:

<u>Particle #</u>	<u>Location</u>
1	n = 5, m = 3
2	n = 13, m = 10
3	n = 6, m = 21
4	n = 4, m = 50
5	n = 13, m = 31
6	n = 7, m = 37

These particles were positioned to determine if the model results were consistent between tests. The tide data for the tests is given in Inclosure 1; the wind speed is assumed to be zero; and the freshwater inflow and the time for the tide to reach the inlet are as follows:

<u>Inlet</u>	<u>Inflow Volume (ft.<sup>3</sup>/sec.)</u>	<u>Time for Tide to Reach Inlet (min.)</u>
Carquinez Strait	10,000	37
Petaluma River	1,000	10
Napa Slough	1,000	15
Napa River	1,000	20

The four disposal sites were located as follows:

1. n = 8, m = 36 (Carquinez site)
2. n = 14, m = 14
3. n = 5, m = 10
4. n = 6, m = 36

The detailed results and a discussion of these four tests is contained in Inclosure 5. The final location of the tracer particles (after 111.11 hours) for each of the four tests are shown in Figures 40-43.

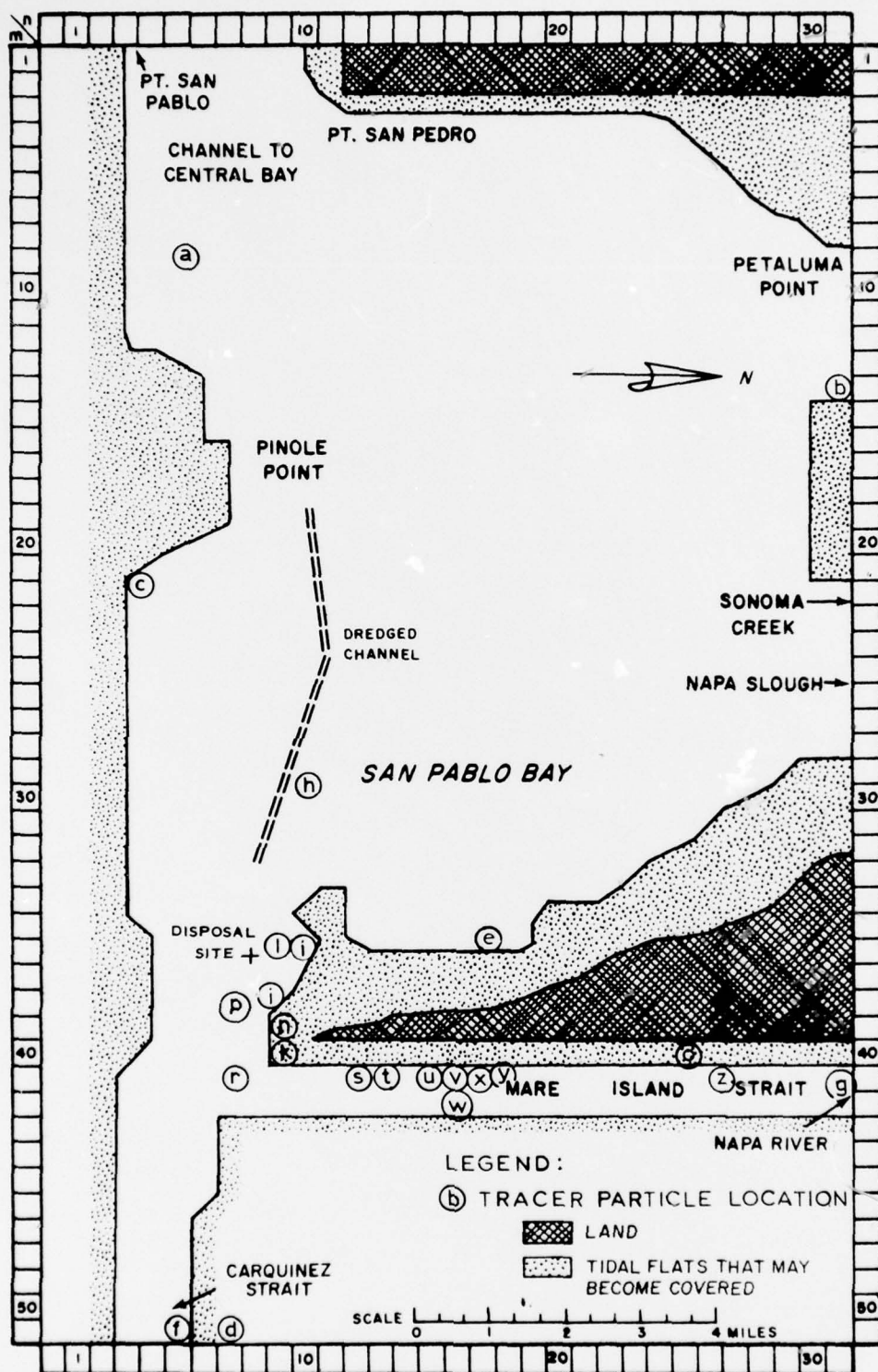
Figure 40 shows the tracer particle locations after several tidal cycles resulting from disposal close to the present Carquinez disposal site. Additional particle location maps for this simulation run for other times can be found in Inclosure 5. However, these figures all show that the particles tend to remain in the vicinity of the disposal site on ebb tide and move into Mare Island Strait on the flood tide. This can be explained primarily by the description of the freshwater inflow boundary at Carquinez Strait and the assumption of negligible vertical velocities in the water column in this area which always keeps the particles traveling along the bottom. Also, there is no allowance for flocculation of material which could keep some particles from entering Mare Island Strait. However, the particle size used, 20 microns, is typical of a floc sized particle and alleviates this problem to some extent. There is no provision in the model to allow the particles to go outside the study area. Hence, when the particles reach a boundary, they remain there until a velocity is developed which can convect the particle back into the study area.

In Figure 41 the disposal site has been moved slightly southward from the site in Figure 40. The difference in particle locations at the end of the simulation runs (111.11 hours) is obvious. In this test the particles appear to become trapped by Pinole Point and subsequently move up into Carquinez Strait. The particles also tend to remain in the shallow areas of the Strait and not in the main channel.

The results of particle movements from disposal at a dump site in San Pablo Bay are shown in Figure 42. Note that the tracer particles have concentrated in the area of Sonoma Creek (Napa Slough) and have moved to the entrance to Central Bay and the southern shallows of San Pablo Bay. Also, two particles are found in Mare Island Strait. Thus, disposal at this site ( $n = 14$ ,  $m = 14$ ) has resulted in a wide dispersal of tracer particles throughout the study area.

Another interesting phenomenon observed in the test with the disposal site at  $n = 14$ ,  $m = 14$  (Figure 42) is that particles 35 and 40, location "n" and "o" in Figure 42, initially move to the boundary in Carquinez Strait. Subsequently, the particles move into Mare Island Strait.

In Figure 43 the disposal site has been moved to  $n = 5$ ,  $m = 10$ . During this test the particles remain on the south side of San Pablo Bay and do not cross the main channel. The majority of the particles remain in the vicinity of Pinole Point.



Locations of tracer particles disposed at  $n = 8$ ,  $m = 36$  (Carquinez Strait Disposal Site) after 111.11 hours.

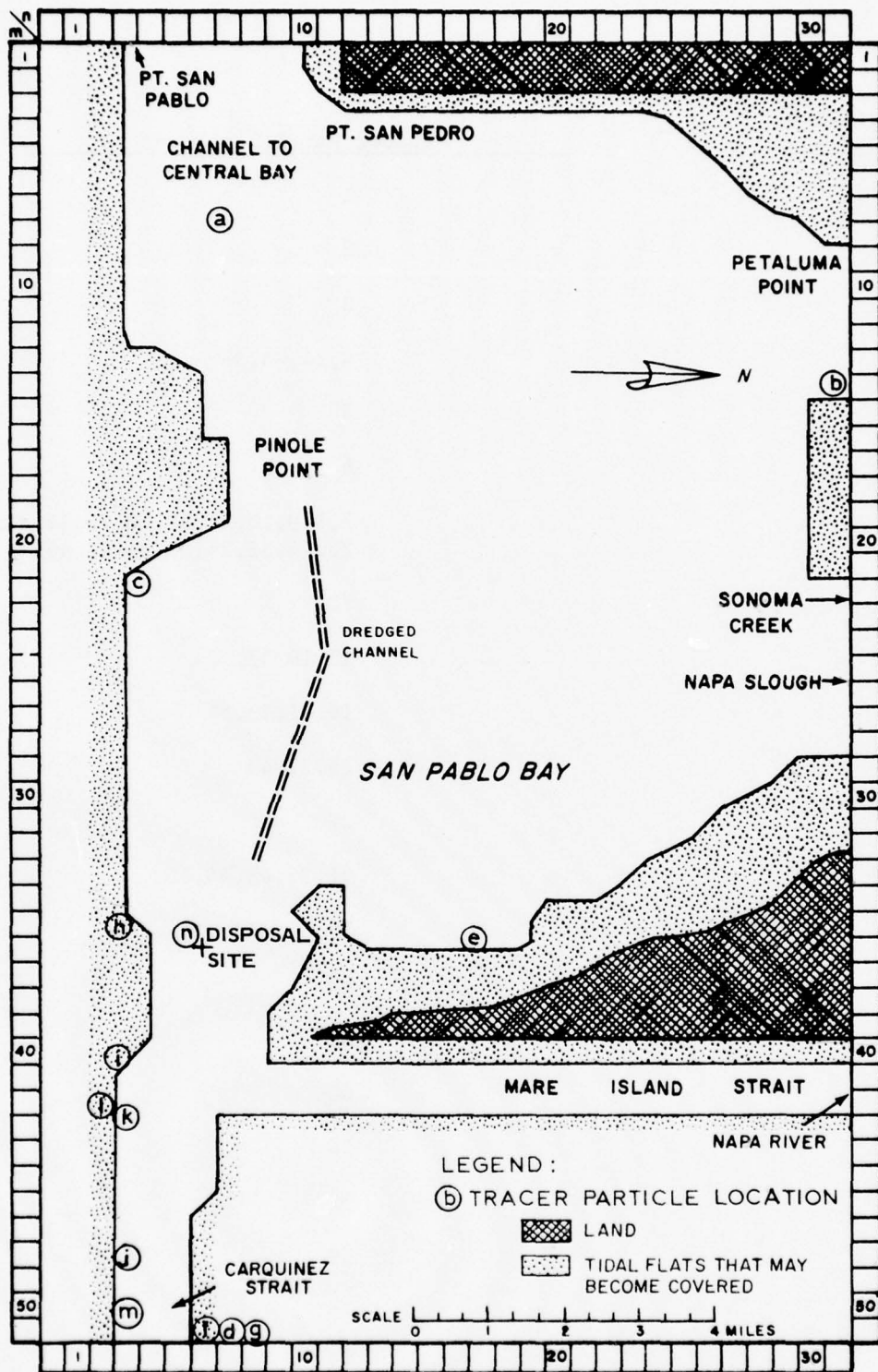
FIGURE 40

Tracer Particle  
Locations

Tracer Particles

a	1
b	2
c	3
d	4,14,26,38
e	5
f	6
g	7,8,9,10,11,17,18,20,21,22, 23,24,33,34,35,36,42,45,46,47
h	12
i	15,19,37,52
j	16,41,53,54
k	25,27,43
l	28
n	31,32,40,44,56
o	39
p	62
r	61
s	60
t	50
u	51
v	59
w	49
x	57
y	58
z	48

FIGURE 40 (CONTINUED)

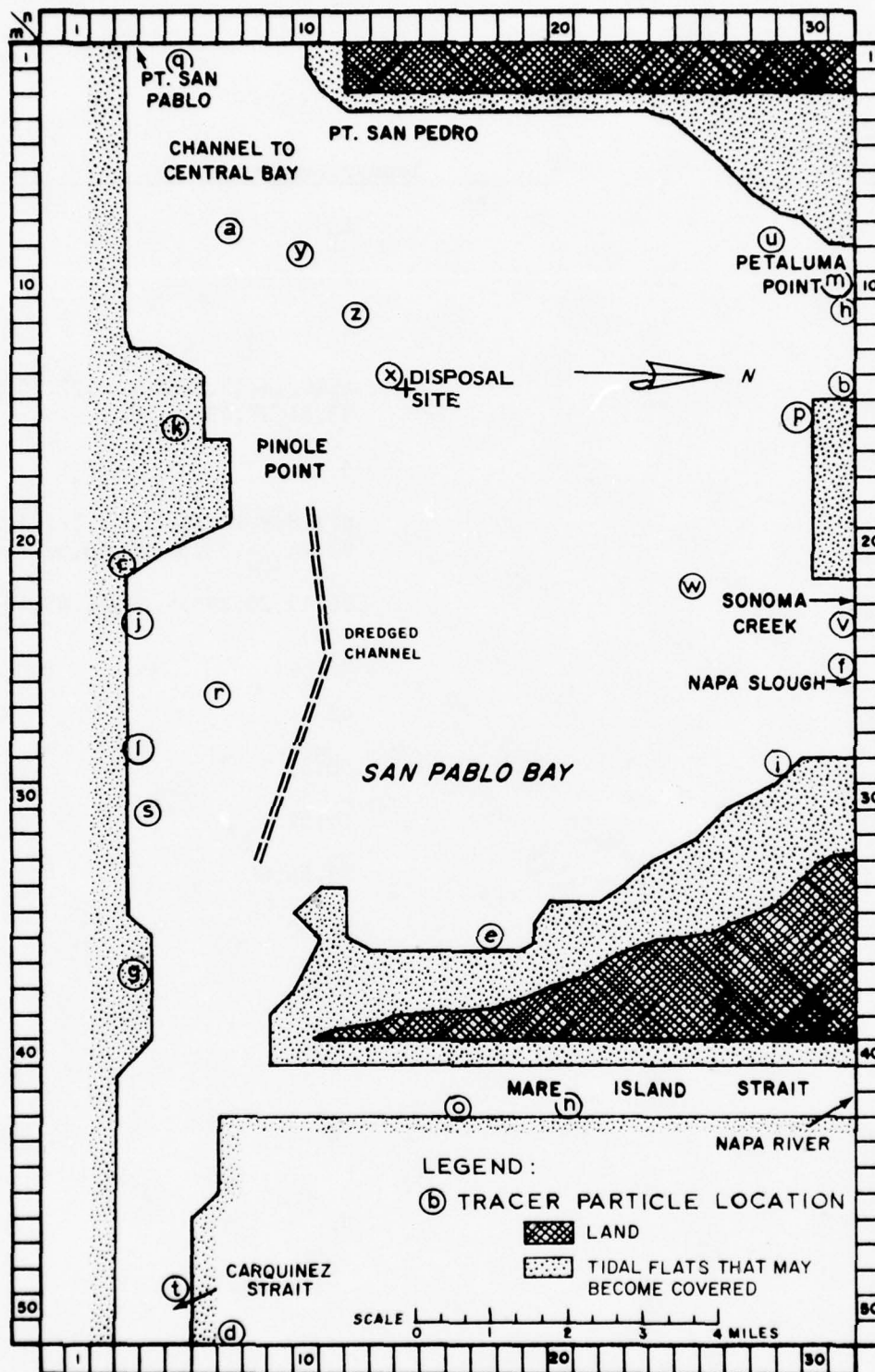


Locations of tracer particles disposed at  $n = 6$ ,  $m = 36$  after 111.11 hours.

FIGURE 41

<u>Tracer Particle Locations</u>	<u>Tracer Particles</u>
a	1
b	2
c	3
d	4, 10, 14, 15, 18, 20, 25, 27, 30, 32, 33, 34, 37, 43, 45, 46
e	5
f	6, 7, 8, 9, 10, 11, 12, 13, 17, 21, 22, 23, 24, 26, 31, 35, 36, 48, 58
g	16, 19, 28, 29, 38, 39, 44, 47, 49, 59
h	41
i	42
j	50, 55
k	51, 52
l	53, 54, 61
m	56, 60
n	62

FIGURE 41 (CONTINUED)



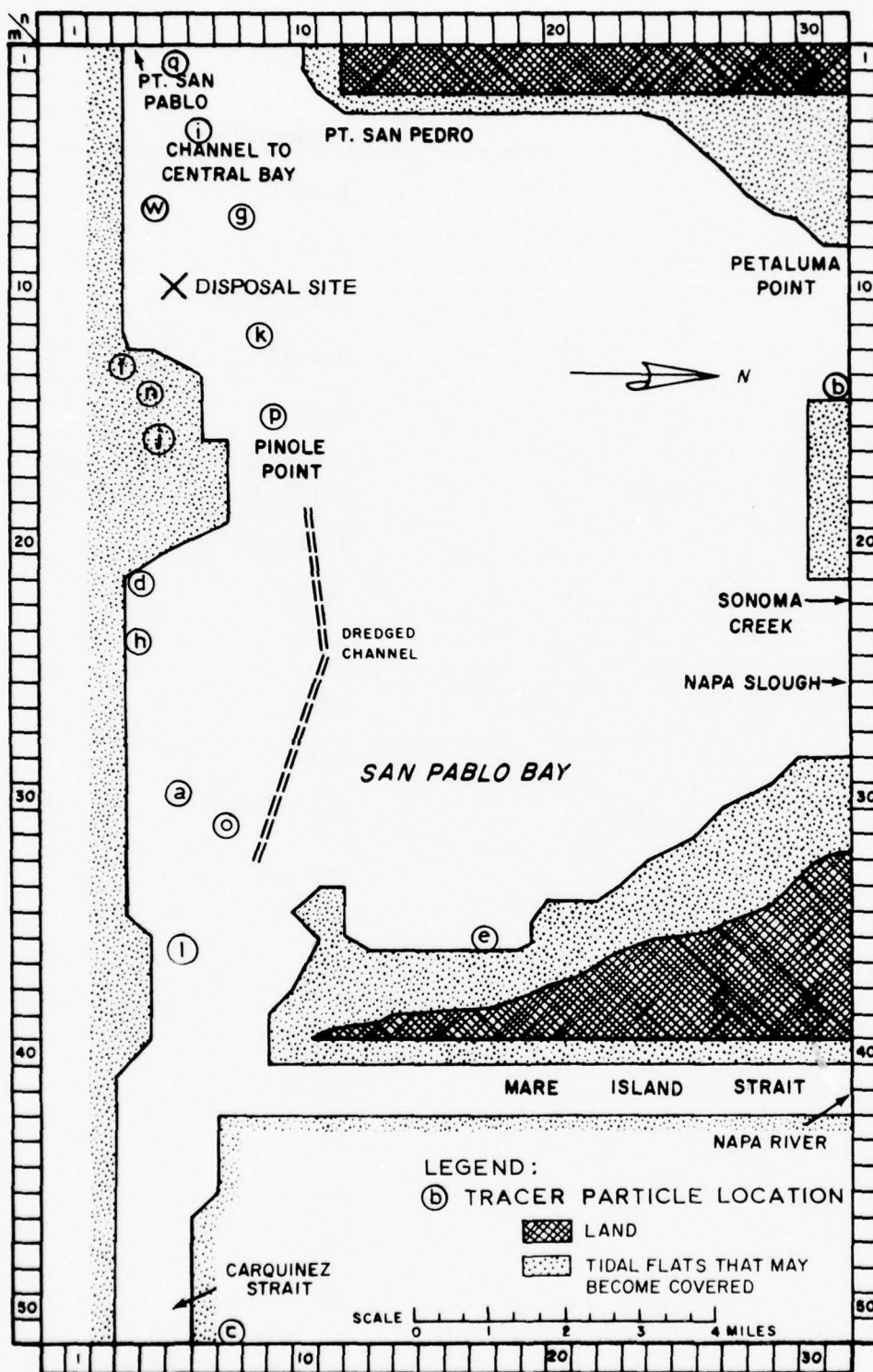
Locations of tracer particles disposed at  $n = 14$ ,  $m = 14$  after 111.11 hours.

FIGURE 42

Tracer Particle  
Locations

Tracer Particles

a	1, 36, 37
b	2, 29
c	3, 12, 13, 25
d	4, 6, 27
e	5, 15
f	7, 8, 9, 10, 17, 18, 19, 20, 21, 30, 31, 32, 33, 34, 42, 43, 44, 45, 46, 55, 57, 58
g	11, 14, 39
h	16, 41
i	22
j	23
k	24
l	26
m	28
n	35
o	40
p	47
q	48, 49
r	50
s	51
t	52
u	53
v	54
w	59
x	60
y	61
z	62



Locations of tracer particles disposed at  $n=5$ ,  $m=10$  after 111.11 hours.

FIGURE 43

<u>Tracer Particle Locations</u>	<u>Tracer Particles</u>
a	57
b	2
c	4, 6, 20,
d	3, 8, 9, 15, 19, 44
e	5
f	7, 18, 30, 42, 43, 52
g	1, 10, 11, 12, 13, 14, 16, 17, 22, 23, 24, 25, 26, 35, 38, 39, 47, 51, 62
h	21, 32, 34, 46, 56
i	27, 28, 29, 36, 37
j	31
k	40, 41, 48, 49, 50
l	45
m	53, 54
n	55
o	58
p	59
q	60, 61

FIGURE 43 (CONTINUED)

## CONCLUSIONS

Based on the various simulation runs made by SRI and reported in Inclosure 5, several conclusions can be made. However, in formulating the conclusions, consideration must be given to the limitations of the model and the short simulation time (111.11 hours).

SRI has advanced two interpretations of the disposal site: it is a disposal site, and it is a transient particle discriminator which means that any particle arriving at a point, from any source, will act like a particle that was externally deposited there. Due to the short simulation time of the test runs the latter interpretation of the disposal site would seem to be appropriate in formulating conclusions about the long-term fate of tracer particles. Another important consideration to keep in mind is that particles are not allowed to leave the study area, but remain at boundaries until resuspended and transported back into the study area.

The following conclusions were made by SRI after analysis of the simulation runs.

(1) A large amount of material moves into Mare Island Strait from disposal of tracer particles in Carquinez Strait and San Pablo Bay and from other suspended material moving through Suisun Bay and Carquinez Strait.

(2) The tracer particles preferentially moved to the following locations:

- a. Mare Island Strait
- b. Carquinez Strait
- c. The southern side of San Pablo Bay, particularly around Pinole Point
- d. The area of Sonoma Creek (Napa Slough)
- e. The mouth of the Petaluma River
- f. The entrance to Central Bay

The simulation runs also indicated that there were no tracer particles found in the main channel through Carquinez Strait and San Pablo Bay, with the exception of particles in transit.

## DISCUSSION

The following sections will present general ideas and information on sediment transport and the fate of released dredged sediments in San Francisco Bay. The discussions will be general; however, the information was developed from results of the sediment tracing program and other Appendices of the Dredge Disposal Study.

### ESTUARINE PROCESSES AFFECTING SEDIMENTATION

Currents were briefly alluded to earlier as mechanisms affecting sediment transport. These include tidal currents, freshwater inflow, salinity-density currents and wind-induced currents.

Tidal currents are a dominating force in San Francisco Bay as they erode, resuspend (turbulent mixing) and transport sediments. The sediments move in suspension and as bedload through Carquinez and San Pablo Straits into Central Bay. Once the sediment-laden waters arrive in broad expanses of San Pablo Bay and Central Bay their velocity and, hence, ability to carry sediments is diminished. At the same time, these brackish waters are mixed with more saline ocean waters and suspended sediments settle to the bottom. These newly-arrived sediments are then subject to movement by other estuarine processes.

Eddy currents can also cause shoaling. Eddy currents are surface gyres (whirls) where water next to the major current moves forward and parallel to the main stream while the water on the opposite side of the gyre flows in the opposite direction. Coves and land points such as Point Pinole along the Bay set off eddy currents which deposit sediments in sheltered, low energy areas down-current of these landforms.

Freshwater inflow is a non-tidal current that affects sedimentation in the Bay. During winter storm runoff, sediment-laden high freshwater inflows generate stratified conductions. Some sediments are deposited while others are transported in the freshwater strata into Central Bay and through the Golden Gate into the Gulf of the Farallones. The sediments are transported in suspension and also dragged along the bottom as bedload. During the wet season, high volume/velocity river currents are especially effective in eroding, resuspending, and transporting unconsolidated sediments.

Freshwater inflow mixes with saline waters in the Bay and results in horizontal and vertical salinity gradients. These gradients are greatest during winter freshets. The difference in salinity and, therefore, density is the driving force of another type of non-tidal current found in the Bay system. Density-salinity currents move upstream along the Bay floor displacing less saline waters moving towards

the Golden Gate in the upper water column. The predominant direction of this current is upstream. This salt-water wedge (vertical salinity stratification) is most developed during wet season storm runoff and is strong enough to erode and transport sediments in the near bottom strata of the water column. The average speed of this near bottom current between the Gulf of the Farallones and San Pablo Bay has been calculated to be 2.2 nautical miles per day (14). Because this current is density-driven, it transports sediments in the deeper parts of the natural and dredged channels. Density-driven salinity currents supplement floodtide bottom filling in tranquil, maintained waterways such as Mare Island Strait and Alameda Naval Air Station and reinforce the tidal regimen by generating a pattern of bottom strata filling and upper strata emptying of the tidal prism in the estuary.

The interface between the fresh and saltwater masses is a zone of vertical mixing and flocculation of colloidal sediments. This results in sediment deposition along the bottom beneath this shifting interface (24). This deposition process occurs in the San Pablo and Suisun Bays and Carquinez Strait regions.

The fourth major physical factor affecting sedimentation is wind-induced current. Wind forces over the surface of the Bay generate wind-drift currents which attain velocities two to five percent of the wind force (25). A seasonal pattern of prevailing winds and resultant wind-drift currents is peculiar to each of the component bays forming the San Francisco Bay system. During the summer, prevailing NW winds blow onshore at the outer coast. However, once these winds reach the Golden Gate, direction and velocity are altered by the channeling effects of the landforms surrounding the Bay. In Central Bay, strong westerly summer winds are funneled through the Golden Gate and produce east setting wind-drift currents. These currents drive sediment-bearing surface waters across the Bay, piling it up along the downwind, eastern shore (wind setup). The same winds are redirected by San Pablo Strait and blow from the south and southwest over San Pablo Bay and into Carquinez Strait (26) generating north and northeast wind-drift currents. During the winter, prevailing winds blow from the north and northeast. These winds produce wind-drift currents flowing through Carquinez Straits, San Pablo Strait and the Golden Gate. These currents increase the competency of freshet and tidal flows to flush unconsolidated sediment from San Pablo and Central Bays. The offshore wind pattern is frequently interrupted by southeast gales associated with winter storms passing from west to east over the Bay Area. These southeast winds are generally of short duration and produce very temporary north-setting currents.

Other factors affecting local sedimentation are prop wash, coriolis forces, and shoreline structures. Prop wash turbulence generated by propeller driven vessels, navigating in shallow harbors and channels, erode, mix and resuspend sediments in the same manner shallow subtidal and intertidal flats are worked upon by wave action. The suspended sediment is susceptible to movement by other types of currents flowing into these relatively tranquil areas. Prop wash is probably a significant factor in redistributing bottom sediments in channels and harbors. Coriolis forces concentrate current flows to the right of their setting direction in the northern hemisphere. In the confined area of the Bay the effect of this force is not great. However, it reinforces or modifies the other more important current forces within the estuary. Man-made shoreline structures (piers, dolphins, groins, and other structures) can affect local sedimentation by creating eddies, still water or turbulence, all aiding flocculation and entrapping of sediments.

Sediment deposition in the Bay system not only depends on tidal and non-tidal circulation conditions described earlier but also on the type of accumulation process, physical characteristics of sediment particles, and concentration and availability of suspended and bedload material. Sediment deposition patterns reflect the energy gradient formed by the dynamic estuarine forces within the Bay. Suspended and bedload material is transported from high energy areas to low energy areas and if the available sediment supply is not a limiting factor, suspended and bedload concentration is directly proportional to transportation energy. Thus, deposition or accumulation zones are situated in tranquil areas where the energy of these forces is dissipated or non-existent.

Postma has shown that on submerged tidal flats, wave action predominates over current velocity as a distributing force (27). Horizontal variation in sediment grain size across the surface of the submerged flats correlates directly with wave energy distribution. Wave action over submerged deposition flats is determined by the force of waves arriving from adjacent deepwater and channel areas, and waves generated over the flats themselves.

In the deepwater and channel areas of the Bay current velocity is the predominant estuarine force. Current force reaches a maximum velocity above the central portions of the channel and diminishes towards the channel banks. This energy gradient is reflected in the decreased sediment grain size away from the channel axis. Areas showing the highest sediment deposition rate in San Francisco Bay are the channel bank zones or channel margins. These accumulation zones are too deep to be affected by wave action and too far away from the channel axis to be affected by strong current velocities; thus, grain size sediments found in the channel bank zones are smaller than sediments situated on the contiguous flats shoreward and on the adjacent channel floor towards deep water. The historical pattern of sediment deposition and erosion rate for San Pablo Bay is shown in Figure 4.

## FATE OF DREDGED MATERIAL DISPOSED IN THE BAY

An estuary such as San Francisco Bay is a sink or holding area for fluvial sediment in transit to the ocean from soil erosion in the Bay's extensive drainage system. Sediment enters the Bay system from the land (via the drainage system), circulates, accumulates, and eventually a portion leaves the system by entering the ocean. Sediment entering the Bay system, then, is either temporarily or permanently held in residence, depending on the dynamic state of the estuary. Twenhofel (28) has described the dynamic state of an estuary as changes in bottom surface elevations or profile of equilibrium. The profile of equilibrium is a condition where the bottom surface has temporarily adjusted to the prevailing physical forces such as wind-wave action and currents which tend to alter the bottom elevation. Since these forces are responsible for maintaining a profile of equilibrium, the profile of equilibrium persists only so long as the forces exist. Surficial bottom sediments quickly respond to changes in these distributing forces. The nature and energy of the forces responsible for development of a profile of equilibrium fluctuate from moment to moment. However, there are seasonal patterns manifested by these forces (e.g., river inflow, wind characteristics, wave climate, tidal action, and sediment availability) that will result in seasonal trends of deposition and erosion. Deposition and erosion in an estuary ultimately depends upon whether or not the bottom surface level has attained a profile of equilibrium with the prevailing forces operating on it.

Inflowing sediment is not, for the most part, carried directly to the ocean. A large percentage of the inflowing sediment remains in residence in the Bay for a number of years, being deposited, then resuspended, recirculated, and redeposited elsewhere, with the net effect of being transported (toward the mouth of the estuary) out of the Bay system into the ocean as suspended load and bedload. This complex process occurs many times before the sediment is either semi-permanently deposited in the Bay or transported as suspended load into the ocean and deposited on the continental shelf.

Before discussing the fate of dredged material released into the Bay, a description of the process of deposition and resuspension of new sediment entering the Bay system is necessary. Most new sediments enter the Bay system during the months of maximum runoff (winter). Eighty percent of the total sediment inflow into the Bay enters from the Central Valley drainage basin via Suisun and San Pablo Bays. When the sediment-laden freshwater mixes with the saltwater, aggregation and settling occur. The broad expanse of the shallow bays, where tidal velocities are low, are the repository areas for the aggregated sediments. During the winter months wave suspension of sediment is at a minimum, allowing accumulation of sediments. In the spring and summer months, daily onshore breezes generate waves over the shallow areas,

resuspending sediments and maintaining them in suspension, while tidal and wind-generated currents circulate them throughout the Bay. The suspended sediments are repeatedly deposited and resuspended in the shallow areas until they are finally deposited in deeper water below the effective depth of wave influence. In spring and summer there is a net movement of sediment from the shallow repository areas, bringing the shallows back to a profile of equilibrium where wave action is no longer influential in resuspending the sediment. Once the sediment reaches deeper water, usually in natural channels or along the margin of these channels, tidal currents become the primary transporting mechanisms. Like the shallow areas (the depths of which are in equilibrium with the depth of effective wave action), the depth of the natural channels are in equilibrium with the flow volume and current velocity in the channel. When resuspended sediments from the shallows are transported into the natural channels, the sediment has a tendency to be transported along the channel in the direction of net flow. In San Francisco Bay the direction of net water flow is towards the ocean, allowing the sediments to have a net seaward component. Sediments may be transported by tidal currents back into shallow areas, especially after the sediment has been transported through a constricted strait into a broad bay, such as through San Pablo Strait into Central Bay, and the recirculation process is repeated.

Some sediment is permanently retained in the Bay system. This sediment is deposited and accumulated in low energy areas where wind-wave action and water flow volumes and velocities are not great enough to transport sediments. These areas may be found along the margins of the Bay such as intertidal flats, marshes and inlets, as well as around manmade structures and dredged channels. Marshes trap sediments much in the same manner as manmade structures by decreasing flow velocities and wind-wave action to the extent where the sediments may no longer be flushed out. In this case, the water depths decrease until a profile of equilibrium is reached. Inlets and sloughs provide sheltered areas with very low current velocities. When suspended sediment enters the inlets the flow velocities and wave action are normally insufficient to remove the sediments, and deposition will occur. Southampton Bay (in Carquinez Strait) near Benicia is an example. Between 1857 and 1886 Southampton Bay had experienced heavy shoaling at the rate of 300,000 cubic yards per year. Since that time the shoaling rate has continuously decreased until between 1922 and 1940 the annual shoaling rate was 43,500 cubic yards. A profile of equilibrium was reached sometime between 1940 and 1950 so that today no net deposition or erosion occurs in the bay (29).

Dredged navigation channels are out of equilibrium with the system in that the channels are maintained to a depth greater than the natural depth. Maintenance of dredged channels is required since the channels, with few exceptions, will attempt to regain the equilibrium depth of their surroundings. Flow velocities in these dredged channels are not great enough to maintain required depths. For this reason, sediment that accumulates in maintained channels will remain there until the channels are dredged.

The source of shoal material in dredged channels has been discussed previously. Shoal material may be derived directly from sediment inflow to the Bay or it may be derived from some part of the resuspension-recirculation-redeposition cycle. Shoaling rates in the dredged channels are not constant but vary from year to year, depending on the variable sediment inflow volume, wind-wave action and current velocities. During a season of exceptionally high sediment inflow to the Bay, for example, dredged channels will normally experience higher sedimentation rates than usual, both in winter and spring-summer seasons. The same process occurs in the shallow areas where the depths of accumulation will be greater, thus reducing water depths. In the spring-summer season shoaling in the dredged channels is due to accumulations of sediment in the shallow areas during the winter. Since the water depth in the shallow areas is less than the profile of equilibrium, and assuming the effective depth of wave-action remains about the same, sediments from the shallow areas will be suspended by wind-wave action in the process of reestablishing the equilibrium depth. As in the winter, this results in a large flux of suspended sediment through the dredged channels and shoaling. High sediment inflow years are characterized by increased suspended solids (turbidity) in the Bay during the winter from direct sediment inflow and in the spring-summer season from the greater volume of sediments resuspended in the shallow areas. High turbidity also results in a larger sediment outflow to the ocean.

Dredging the shoaled sediments in navigation channels with disposal at one of the disposal sites in the Bay has the effect of redistributing the sediments within the system. As discussed in the preceding paragraph, the origin of the shoaled sediment is from the direct inflow of sediment-laden river water, and resuspension and recirculation of sediment in the Bay's shallow areas. Disposal of dredged sediments in the Bay brings back into circulation material that could otherwise remain out of circulation (retained in the channel). Upon disposal, the dredged sediment will reenter the deposition-resuspension-redeposition cycle, eventually being permanently placed in low energy areas or carried to the ocean. Since dredged channels are out of equilibrium, a portion of the disposed dredged material will likely reenter the same or other dredged channels.

Sites for disposal of dredged material in San Francisco Bay are along the channel margins or in natural channels. No net accumulation of dredged sediments in any of the disposal sites has been detected since disposal operations at the sites were initiated. Disposal of dredged sediment in these high current velocity areas and the present practice of using the closest disposal site towards the ocean from the dredging site has the effect of eliminating one or more steps of the resuspension-recirculation-redeposition cycle in the process of transporting sediments through the estuary to the ocean. Studies conducted and reported in Appendices C and M of the Dredge Disposal Study indicate that a large amount of dredged sediments after disposal will be transported in the channel as bedload or as a high solids content suspended

load. The major transporting mechanism of the dredged sediments in the natural channels is by tidal currents and occurs at depths greater than the depth of effective wave action. Just as the water has a tendency to remain in the natural channels, as evidenced by the high current velocities, dredged sediments also have a tendency to remain within the confines of the natural channels for at least a short period of time.

The natural channel network leading to the ocean in the Bay is not continuous, causing the dredged sediments, like the natural sediments, to leave the boundaries of the natural channels and move onto the shallows as part of the resuspension-recirculation-redeposition cycle. The dredged sediments moving onto the shallows are dispersed and do not inhibit the system's ability to resuspend and recirculate the material. In contrast, if "low wave energy-low current energy" disposal sites were used for deposition of dredged sediments in the Bay, the ability of the system to assimilate the dredged sediment or the ability of the dredged sediment to reenter the resuspension-recirculation cycle could be significantly reduced. For example, disposing in the north San Pablo Bay shallows during the winter, when wind-wave resuspension is at a minimum, could, conceivably, cause a large enough accumulation of dredged sediments that wind-wave resuspension in the subsequent spring-summer season would be insufficient to remove all the material. The result of such an action would be a decrease in the water depth in the surrounding area, further decreasing the wave action and ability to resuspend and circulate the sediment. This would disrupt the existing equilibrium, resulting in a net accumulation of sediments in the shallows.

## CONCLUSIONS

The primary objectives of the study were to determine the long-term movement of sediments in terms of the extent and degree of impacts and the efficiency of the disposal operation at the Carquinez disposal site.

The dispersion of sediments released at the Carquinez disposal site was found to be very rapid and wide-spread. During the disposal operation, dredged sediments made up a large percent of the total bottom surface sediments in the vicinity of the disposal site. Sampling showed that within a month, released sediments were well distributed both horizontally and vertically over a 100 square mile area including San Pablo Bay, Carquinez Strait and Suisun Bay. The released sediments were well mixed to depths of at least 9 inches at the major portion of the sampling stations in April, having concentrations of dredged sediment less than 4 percent. The general concentration decreased to less than 0.5% in August. In September and October a significant increase in percentage of dredged sediments appeared. The increase is attributed primarily to the estuarine processes (i.e. wind-wave resuspension) which resuspend, circulate and deposit sediments within the study area. A secondary cause was the dredging of sediments which had returned to Mare Island Strait. Within two months after the September-October increase most of the dredged sediment had again disappeared from the top 9 inches of the study area.

The efficiency of the disposal operation at the Carquinez Strait disposal site is based on the quantity of sediments returning to Mare Island Strait and other navigation channels. Initial movement of sediments back into Mare Island Strait channel was estimated to be 10 percent of the total volume dredged. The conditions which occurred during the disposal operation with the salt water wedge moving with the tides across the entrance to Mare Island Strait should have provided a maximum or upper limit on the sediments returning. The percent returning is consistent with results of previous model and field studies. Recirculation returns additional sediments to the channel. The estimated total sediments, both initial and long-term movement, returning to the Mare Island Strait channel is estimated to be no more than 15 percent.

Sediments were also found in other navigation channels. As expected, sediments were found to pass through Pinole Shoal Channel with net movement seaward toward Central Bay. Accumulation was not expected to occur because of the high energy environment of the channel being more favorable to coarser sediments. The amount of energy (i.e. tides, wind-waves, etc.) available to a particular area in the system will determine the type of sediment favorable for deposition. Small quantities of dredged sediments were estimated to move into small craft marinas on the south side of Carquinez Strait. This shoaling, however, is predominantly a function of natural recirculation of sediments in the

system and the location and configuration of the marinas rather than a direct result of the location of the disposal site.

The secondary objective was to provide additional information on the dynamics of the sediment system in the Bay.

Within Carquinez Strait, the salt water wedge is a major factor in the transport of sediments. Because of this, Suisun Bay initially experienced a high rate of deposition of dredged sediment. The residence time of the sediments, however, was very short.

The layer of active sediments (sediment subject to mixing and recirculation) was found to be at less 9 inches. Limited amounts of tagged sediments, however, were found at depths of over two feet below Bay bottom in the shallows and flats, indicating that major mixing occurs during and after deposition.

Preferential movement of sediment under varying conditions in the estuary was demonstrated. This preferential movement supports the theory that sediments experience a residence time in the various embayments as they tend to move seaward. With the initial release, a portion of the sediments are transported through the deep water channels to the next embayment and dispersed (i.e. Central Bay).

Other sediments are dispersed immediately in San Pablo Bay. These sediments after a period of time are again subject to transport seaward when circulation conditions change. The residence time coincides with the annual climatic and hydrologic cycle.

This study using neutron activation methods has demonstrated that fine-graining sediment movement can be quantitatively traced in an estuarine environment. The demonstration of the dynamics of the sediment regimes from the tracer program has shown major limitation in mathematical model assumptions of complex estuarine areas.

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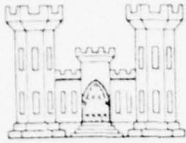
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INCLOSURE 1

U.S. Army Engineer Waterways  
Experiment Station report, Dredged  
Sediment Movement Tracing in  
San Francisco Bay Utilizing  
Neutron Activation



DREDGED SEDIMENT MOVEMENT TRACING IN  
SAN FRANCISCO BAY UTILIZING NEUTRON ACTIVATION

by

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Final Report

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## PREFACE

The development and use of a neutron-activable chemical element tracer for following the movement of dredged material dumped into the waters of San Francisco Bay was sponsored by the U. S. Army Engineer District, San Francisco. The work was funded under the accounting classification 96 x 3123 O&M General, Civil, Corps of Engineers. This report has been submitted as a part of the San Francisco District's overall study and is incorporated in Dredge Disposal Study, San Francisco Bay and Estuary, "Material Release Study," Appendix E.

The research was conducted by the Explosive Excavation Research Laboratory (EERL) of the U. S. Army Engineer Waterways Experiment Station (WES) with contractual assistance by Stanford Research Institute (SRI) of Menlo Park, California. The San Francisco District conducted the sampling program in the Bay. The Director of EERL was LTC R. R. Mills, Jr. The San Francisco District Engineers were COL J. L. Lammie and COL H. A. Flertzheim, Jr. Messrs. J. F. Sustar and R. M. Ecker of the San Francisco District monitored the research effort and devised and conducted the sampling program. This report was prepared by Messrs. E. J. Leahy, W. B. Lane (formerly with SRI), T. M. Tami, L. B. Inman (SRI), W. R. McLoud, and Major N. J. Adams.

Sincere appreciation to the following individuals for their contributions to this effort is expressed:

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3. Messrs. Forrest Allphin and George Perry of the San Francisco District along with the boat crew for the conduct of the sampling program in San Francisco Bay.

4. Mr. Ruben Carter of the U. S. Navy's Mare Island Naval Shipyard for his assistance in obtaining sediment material to be tagged.
5. Captain Martin Jarvis and crew of the Corps of Engineers dredge, the Chester Harding, for the splendid cooperation during all efforts required to install equipment, load traced dredged material, and add traced material to the 706 individual loads dredged from Mare Island Strait.

Members of the EERL deserve special thanks for their efforts in adding the traced sediments to each of the loads of dredged material on an around-the-clock basis, during a total of 35 days of dredging.

Those performing this dirty task in all types of weather were: SP5 W. R. McLoud, SP5 J. F. Dishon, SP5 R. J. Gerbino, SP4 M. F. Goodrich, SP4 M. J. Hoeft, SP4 S. C. Kelley, and SP5 A. B. Steen.

Directors of the WES during the conduct of this work were BG E. D. Peixotto, CE, and COL G. H. Hilt, CE. Technical Director was Mr. F. R. Brown.

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CONVERSION FACTORS, METRIC (SI) TO U. S. CUSTOMARY  
UNITS OF MEASUREMENT

Metric (SI) units of measurement used in this report can be converted to U. S. customary units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
millimetres	0.03937007	inches
centimetres	0.3937007	inches
metres	3.280839	feet
metres	0.00053	nautical miles
square centimetres	0.1550	square inches
square metres	10.76391	square feet
square metres	$2.809 \times 10^{-7}$	square nautical miles
square kilometres	0.0002809	square nautical miles
cubic centimetres	0.06102376	cubic inches
cubic metres	1.30795	cubic yards
cubic metres	264.172	gallons (U. S. liquid)
millilitres	0.03381	fluid ounces
litres	33.81	fluid ounces
micrograms	$0.002204622 \times 10^{-6}$	pounds (mass)
grams	0.002204622	pounds (mass)
grams	$1.016047 \times 10^6$	long tons
grams	0.03215	troy ounces
kilograms	2.204622	pounds (mass)
grams per cubic centimetre	0.0361273	pounds (mass) per cubic inch
kilograms per cubic metre	0.06242797	pounds (mass) per cubic foot
centimetres per second	0.3937007	inches per second
centimetres per second squared	0.3937007	inches per second squared
radians	57.29578	degrees (angular)
Celsius degrees or Kelvins	9/5	Fahrenheit degrees*

\* To obtain Fahrenheit (F) readings from Celsius (C) readings, use the following formula:  $F = 9/5(C) + 32$ . To obtain Fahrenheit readings from Kelvins, use:  $F = 9/5(K - 273.15) + 32$ .

DREDGED SEDIMENT MOVEMENT TRACING IN  
SAN FRANCISCO BAY UTILIZING NEUTRON ACTIVATION

PART I: INTRODUCTION

Purpose

1. This research was conducted for the U. S. Army Engineer District, San Francisco. Its purpose was to develop a technique which would permit the long-term tracing of the movement of dredged material after aquatic disposal in San Francisco Bay. The research objectives were to identify neutron-activable chemical elements suitable for use as tracers, develop sediment tagging and sample analytical methods, and conduct a large-scale sediment tracing experiment.

2. The first application of the technique involved tagging and tracing the movement of approximately 1,500,000 m<sup>3</sup>\* (2,000,000 yd<sup>3</sup>) of material dredged in the February-March 1974 time frame from the Mare Island Strait. Mare Island Strait is located adjacent to the city of Vallejo, California, and serves as the water access to the U. S. Navy's Mare Island Naval Shipyard.

Scope

3. The report describes the research efforts conducted to (a) identify the chemical elements suitable for use as a neutron-activable tag, (b) place the chemical element on a measured quantity of sediment material from Mare Island Strait, (c) introduce a portion of this tagged sediment material into the dredge hoppers during dredging operations, and (d) analyze collected sediment samples to determine the concentration of released sediments in the 316-km<sup>2</sup> (92 square nautical miles) area in and about Mare Island Strait. Interpretation

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\* A table of factors for converting metric (SI) units of measurement to U. S. customary units is presented on page 7.

of the sample data presented in terms of sediment circulation and shoaling will be performed by the San Francisco District and is the subject of a separate report.

4. A complete listing of all data collected during the March-December 1974 sampling of San Francisco Bay is contained in Appendix A, which is published under separate cover. Copies may be requested from the U. S. Army Engineer Waterways Experiment Station Technical Information Center.

#### Background

5. The San Francisco District is currently conducting a study titled "Dredge Disposal Study: San Francisco Bay and Estuary." The basic objective of the study and its many study elements is to assess the impact of dredging on the Bay and to recommend methods to mitigate identified adverse effects or enhance the marine environment. The Tracer Program of the Material Release Study Element, in which the dredged material was physically traced by tagging dredged material with a neutron-activable chemical element, is directed toward determining the disposition and dispersion patterns of dredged materials released at the Carquinez Strait aquatic disposal site. The results of the Tracer Program will be used to verify a mathematical model of the study area. Once verified, the mathematical model will permit studies to be performed for a variety of hydraulic parameters and dredge disposal conditions.

6. Previous tracing tests<sup>1-3</sup> using a radioactive material, gold-198, have been conducted in the Mare Island Strait. These tests, summarized in Reference 4, provided information on the dispersion of materials entering Mare Island Strait but, because of the short half-life of gold (2.7 days), did not permit following the material movement over a long period of time. To follow the movement of material over a long period of time with radioactive tracers, either the quantity of radioactivity must be increased if a short half-life material is used, or a radionuclide with a longer half-life must be employed. Both

alternatives are objectionable since they pose certain radiological hazards. An alternative approach employing short half-life radioactive material is to follow the material to a point and then introduce additional radioactive tracer, repeating the process as necessary. This approach has not been attempted. It presents the problem of introducing materials periodically in a manner which distributes this material as it would be by the natural processes of the Bay environment. The method used in this study is neutron activation. In this method, no radioactivity is involved until after the samples are collected; therefore, no environmental hazard is presented, provided the trace element employed is either nontoxic, or, if toxic at high concentration, is employed in a very low concentration, or is affixed to the sediment so that it is not available to biological systems. Also, neutron activation provides a very sensitive tracing technique since submicrogram quantities of many tracer elements may be detected with considerable accuracy.

#### Neutron Activation Technique

7. The technique of using neutron activation and gamma-ray spectrometry is detailed in numerous textbooks. In the subsequent paragraphs, a very brief outline of the technique is presented for readers not familiar with the process.

8. Many chemical elements, when exposed to thermal neutrons in a nuclear reactor or from some other neutron source, become radioactive by capturing neutrons in nuclei of individual atoms of the element. The radioactive atoms (radionuclides) of each element thus formed decay by giving off energy. This is generally in the form of an electron (beta particle) and one or more gamma rays. Each radionuclide in its decay process emits beta particles and any accompanying gamma ray(s) at a distinct rate. The radioactivity of a particular radionuclide is expressed as disintegrations per unit of time, generally disintegrations per second (dis/sec). The period of time required for a particular radionuclide to lose 50 percent of its activity by decay is known as its "half-life." When the disintegration (decay) process is accompanied

by one or more gamma rays, the gamma rays have a distinct energy which is characteristic of the specific atomic mass and chemical species of the decaying radionuclide and serve as identifiers of that radionuclide. The gamma-ray energy emitted by a radioactive material is measured in either thousands of electron volts (keV) or millions of electron volts (MeV).

9. As an example, gold-197 ( $^{197}\text{Au}$ ) when exposed to thermal neutrons forms gold-198 ( $^{198}\text{Au}$ ) which is radioactive.  $^{198}\text{Au}$  emits beta particles in its decay process which are accompanied by 0.411-MeV gamma rays. The half-life of  $^{198}\text{Au}$  is 2.7 days, i.e., after 2.7 days, one would have only one-half of the original mass of radioactive  $^{198}\text{Au}$  as was present at time zero. Iridium-192 ( $^{192}\text{Ir}$ ) is also radioactive and results from capture of thermal neutrons by iridium-191 ( $^{191}\text{Ir}$ ).  $^{192}\text{Ir}$  emits beta particles in its decay process accompanied by a number of gamma rays (15 distinct gamma rays). The principal gamma-ray energies are 0.295, 0.308, 0.316, and 0.468 MeV. Iridium-192 has a half-life of 74.37 days.

10. Measuring the gamma-ray energies being emitted by a neutron-activated sample, with a suitable detector and a gamma-ray spectrometer, identifies the neutron-activable chemical elements present. If the gamma-ray emission rate and neutron exposure of the sample are known (flux and time in flux), the quantity of each of those elements can be calculated.

11. In the neutron activation technique of tracing sediment materials, a small amount of a chemical element not naturally present in the sediments (or present in very low concentrations of at least a factor of five less than that being added) is fixed to a quantity of the sediment and subsequently introduced into the environment of interest. After some period of time, samples of the environment are collected, processed, neutron activated, and the gamma-ray spectra determined. From this data, the presence of the tracer can be quantitatively determined. Knowing the tracer concentration placed on the original quantity of sediments and the amount of this material added to each hopper load allows the percentage of the larger quantity of traced and dumped sediments in a sediment sample to be determined.

## PART II: TRACER SELECTION

### Conditions Affecting Tracer Selection

12. In selecting the neutron-activable chemical element to be used as a tracer for a particular task, four conditions must be met.

- a. The chemical element to be used as the tracer must not be naturally present in any significant concentration in the medium being traced and the media with which the traced material may mix. A significant concentration could be defined as a concentration that will not permit addition of a sufficient amount of tracer to produce a quantifiable signal over and above that resulting from the amount naturally present. If the element is naturally present and detectable it must be uniformly distributed, i.e., the natural concentration of the element would remain constant in all samples to be examined.
- b. The chemical element must permit homogeneous labeling of the material to be traced and, for sediments in a marine environment, must remain fixed to the particulates of the sediments and not alter their settling characteristics.
- c. The mass of tracer to be added must be compatible with the mass of sediment material that may be physically handled during the tagging process.
- d. The chemical element employed must not be a toxic substance to the life forms in the environment of the experiment.

13. Other factors must be considered during the tracer selection process but are not controlling. For a rapid and least cost detection technique, one would like to directly examine the neutron-activated samples. To permit direct examination, the trace element must be detectable in the presence of background activities formed by neutron activation of the natural chemical elements in a sample. In many instances, direct examination is not possible. For example, when tracers with a short half-life are used, the radioactive sodium ( $^{24}\text{Na}$  with a 15-hr half-life) created when most mineral particles are irradiated will prohibit direct examination at early postirradiation times; at later times the short half-life tracer's signal may have decayed. For long half-life tracers when the concentration of the tracer in a sample is low,

direct examination of the sample may be prohibited by a poor signal-to-noise ratio. When direct examination of the sample is not possible, more intricate and time-consuming chemical separations are necessary to recover the trace element for analysis. Thus, in selecting a tracer, the cost of the analytical technique and the cost of the trace element must be considered, and the total cost minimized.

14. The physical facilities available for neutron activation are also a consideration in tracer selection. For a large program involving several thousand samples, it is desirable to irradiate as many samples as possible at one time to minimize irradiation costs. Irradiation of large numbers of samples also requires selection of a tracer with a half-life sufficiently long to permit the analysis of each sample before radioactive decay reduces the tracer element's signal.

#### Gamma-Ray Spectra of Bay Sediments

15. Figure 1 is a general view of the San Francisco Bay area. Figure 2, an enlargement of a portion of Figure 1, shows the disposal site for traced dredged material from Mare Island Strait and the test areas to be sampled. These consist of the San Pablo Bay, Mare Island Strait, Carquinez Strait, and Suisun Bay areas.

16. To determine the gamma-ray spectra of the sediments to be dredged from Mare Island Strait and the sediments of the test areas with which the dredged material could mix, the San Francisco District provided 21 samples from the locations shown in Figure 2. The sediments were dried, and two 1-g samples from each location were irradiated for 1 hr at a flux of  $5 \times 10^{12}$  neutrons per square centimetre per second ( $n/(cm^2 \times sec)$ ). The gamma-ray spectrum of each sample was examined about every third day between 3 and 40 days postirradiation. No significant spectral differences were noted among the samples, indicating the neutron-activable chemical elements were uniformly distributed in the sediments. To further verify the sediments' gamma-ray spectra and to estimate the quantity of particular elements, the Radio-Chemistry Division, Lawrence Livermore Laboratory (LLL), also analyzed the samples in

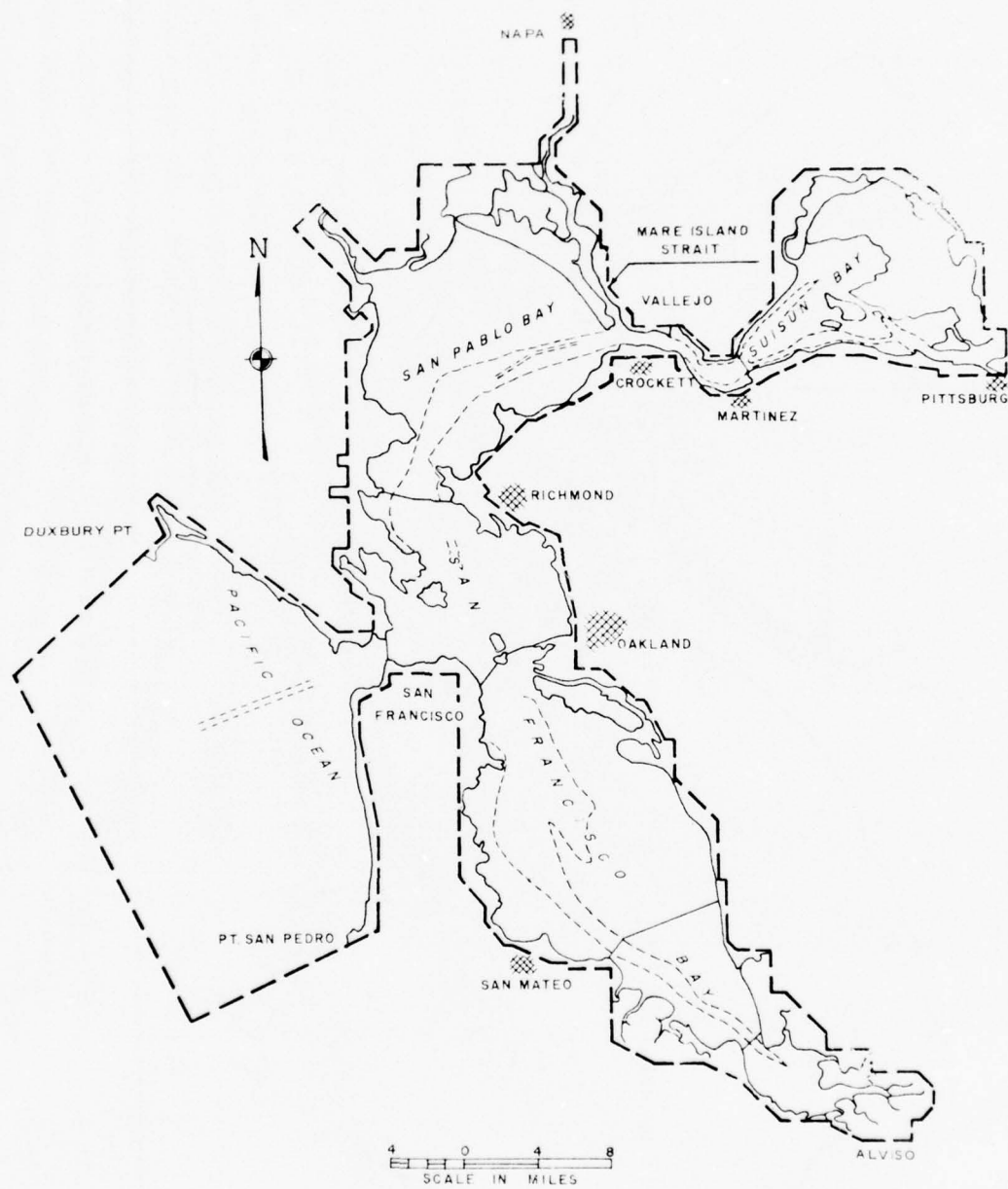


Figure 1. General view of San Francisco Bay area

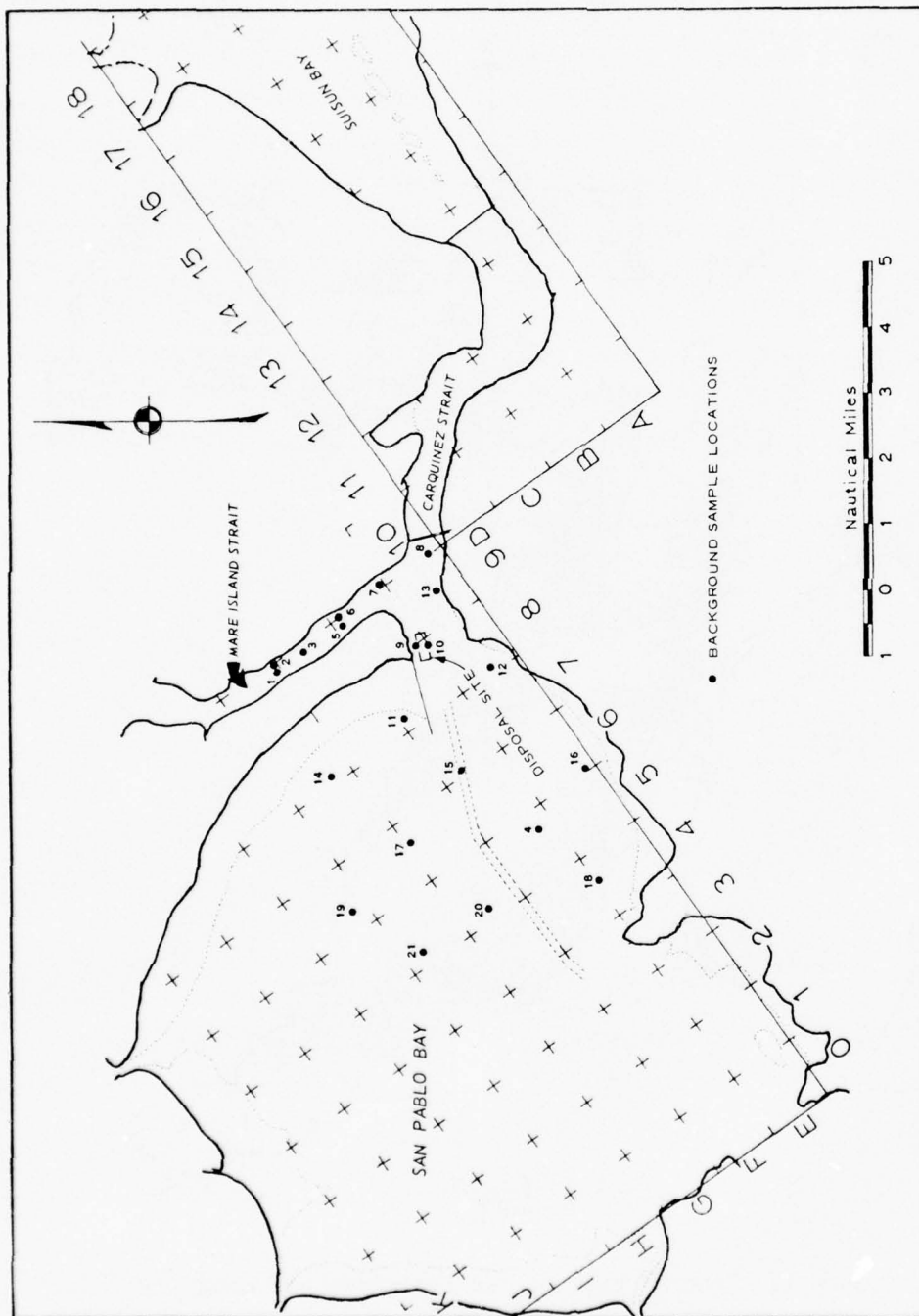


Figure 2. Test area for traced dredged material study

their computerized gamma-ray spectral analysis system, GAMANAL.\*<sup>5</sup> This examination was performed at 13 days postirradiation to permit the <sup>24</sup>Na in the samples to decay to an insignificant level. Figure 3, produced by the LLL counting system, is a 0-2000 keV plot of the spectrum from a sediment sample. The ordinate is total counts (66-min counting time), and the abscissa is the channel number, which may be converted to gamma-ray energy in keV by dividing by 2. In the figure, each major gamma-ray photon peak is labeled as to its energy in keV.

17. The GAMANAL program also identifies the radionuclides present and assigns a percent of error to the identification. The 30 nuclides identified in the Bay sediments are listed in Table 1. Again, no significant differences were noted in the activation products of any sample. Caution is required in using this listing for other than rough estimates since the GAMANAL Code was designed for analysis of fission product mixtures and not thermal neutron activation products. In addition, the efficiency of the system for the sample geometry was not determined. As a result of the code construction and the assumed geometry, some nuclides are identified which do not result from thermal neutron activation, and the quantities are overestimated.

18. To obtain quantitative concentration information for the thermal neutron-activable chemical elements, similar sediment samples

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\* The GAMANAL program is primarily intended for complete computer analysis of high-resolution gamma-ray spectra obtained from mixtures of radioactive species such as fission products. For this purpose, it examines the pulse-height data for "background" and "peak" regions, fits these peaks with the proper shape functions, and corrects for the effects of geometry, attenuation, and detector efficiency in evaluating the photon emission rate and for nonlinearities in the equipment in setting up an energy scale. These intermediate results are listed and plotted; if no further data reduction is requested, the program goes on to the next spectrum. Otherwise, it proceeds to search a "library" of decay scheme information in order to make tentative assignments for each of the peaks. This collection of "candidates" is examined for interactions between the photopeaks of the proposed nuclides and is divided into sets of species which interfere with each other at any point. A least-squares solution of the corresponding set of simultaneous equations is made, and the amounts of various components originally present are calculated and listed, along with their estimated errors.

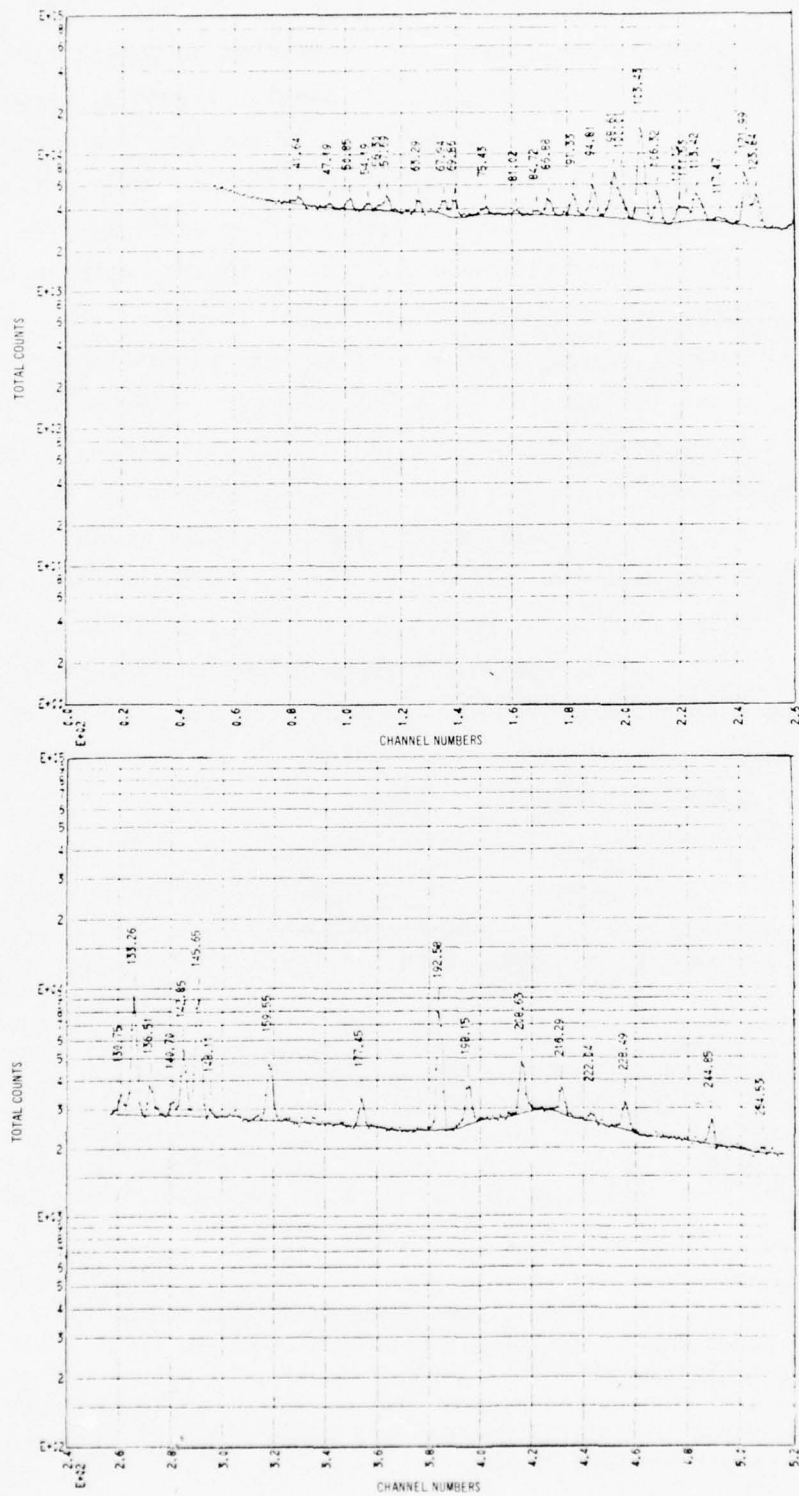


Figure 3. Gamma-Ray Spectra of San Francisco Bay Sediments (sheet 1 of 8)

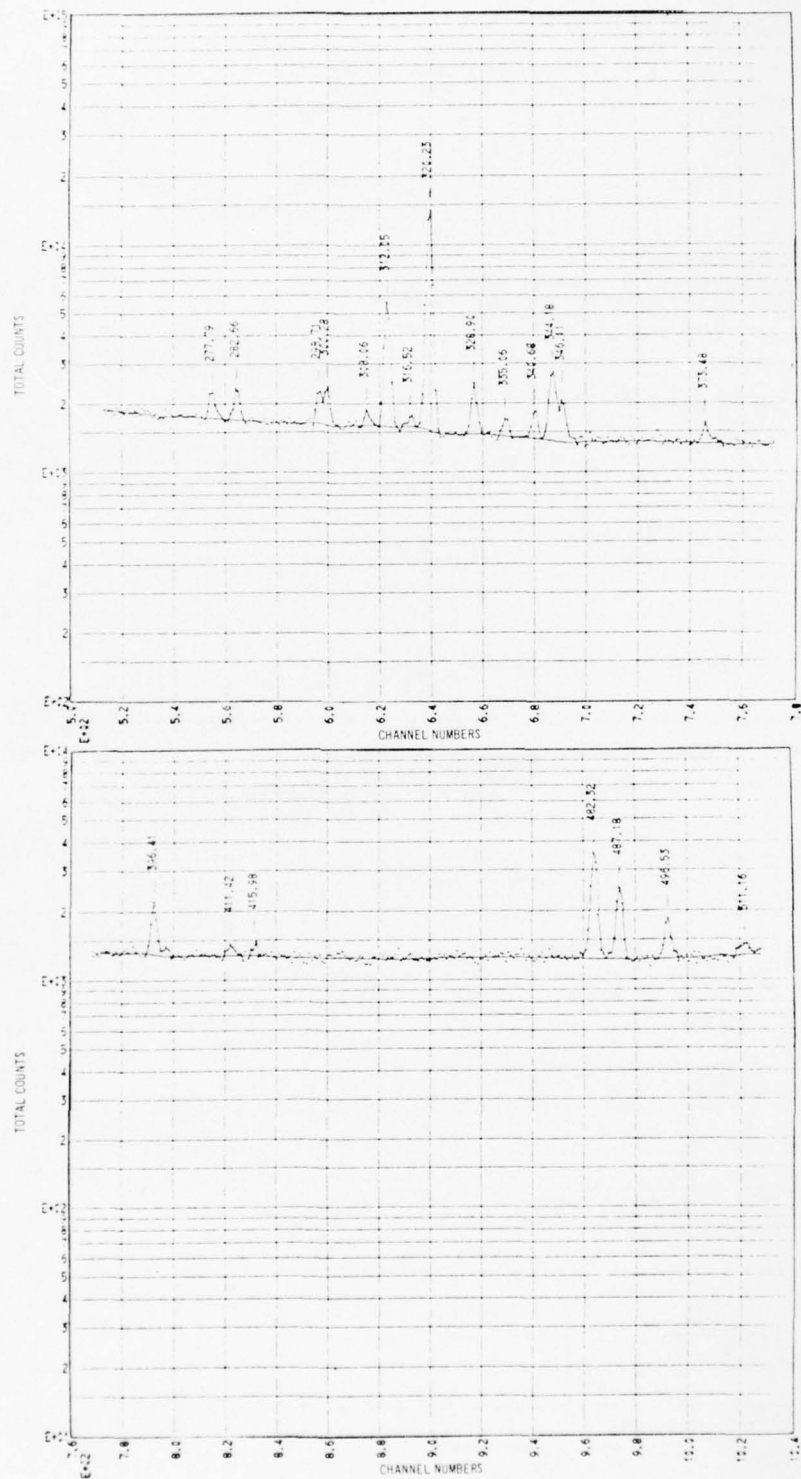


Figure 3. (sheet 2 of 8)

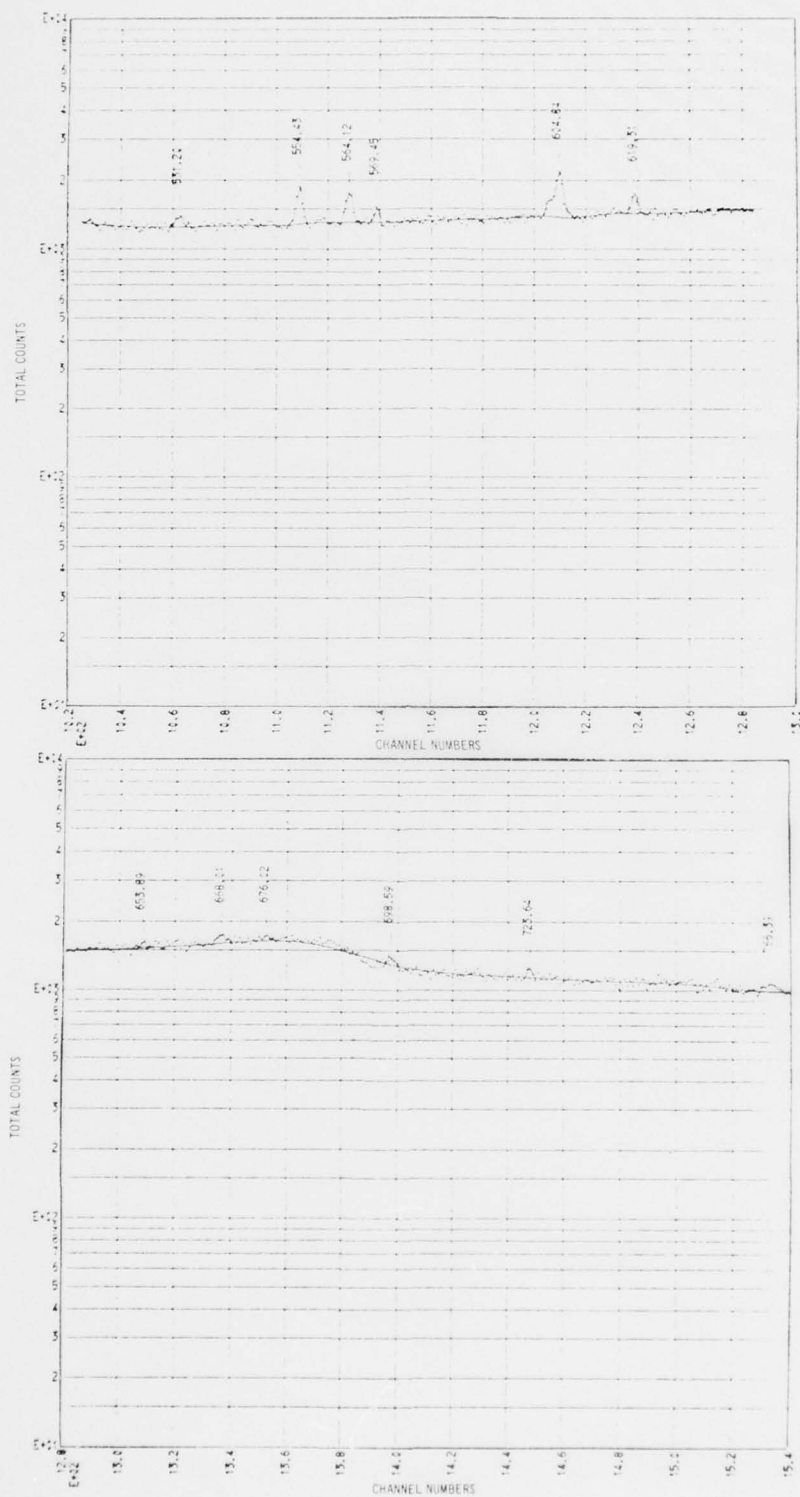


Figure 3. (sheet 3 of 8)

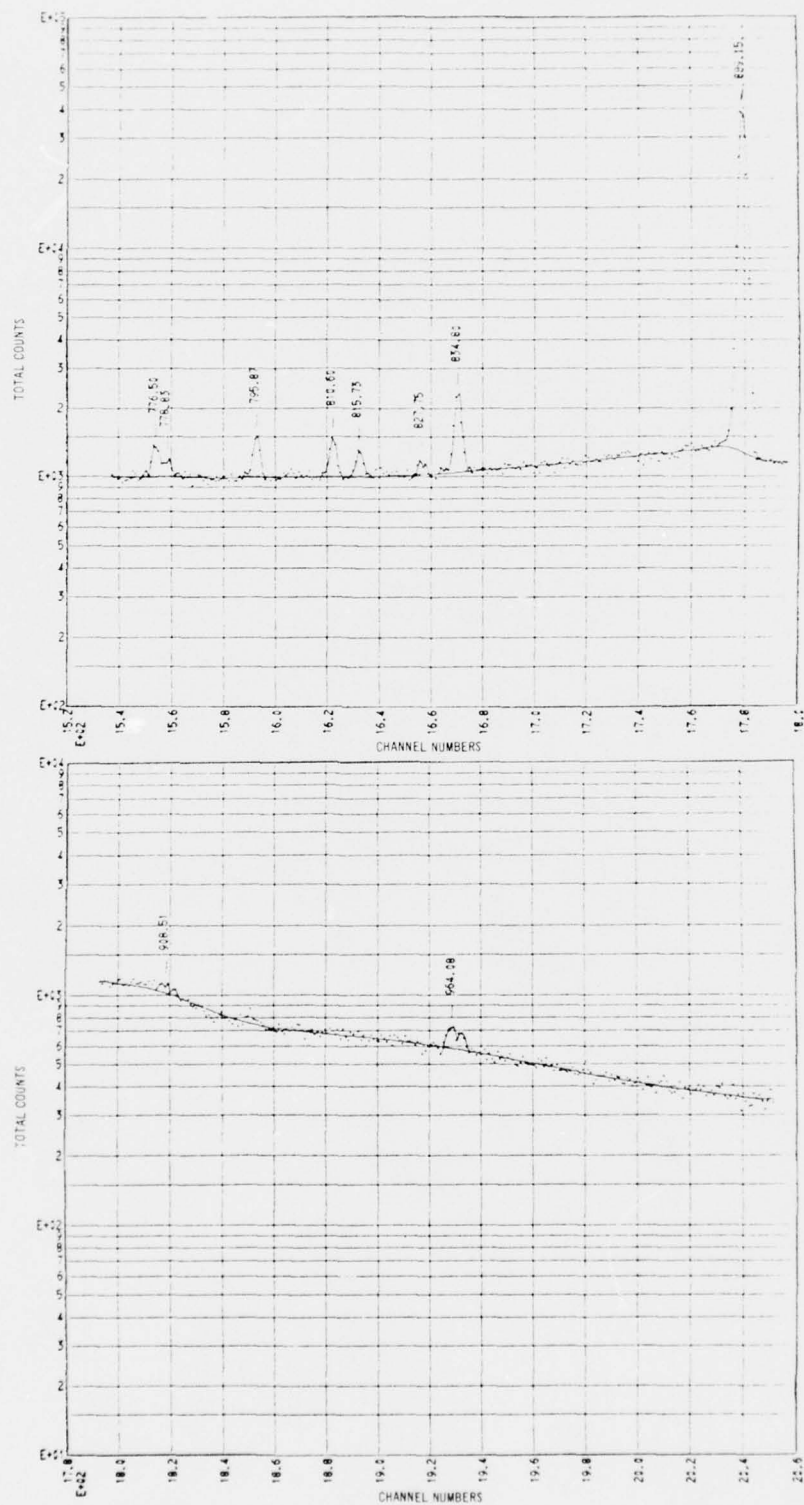


Figure 3. (sheet 4 of 8)

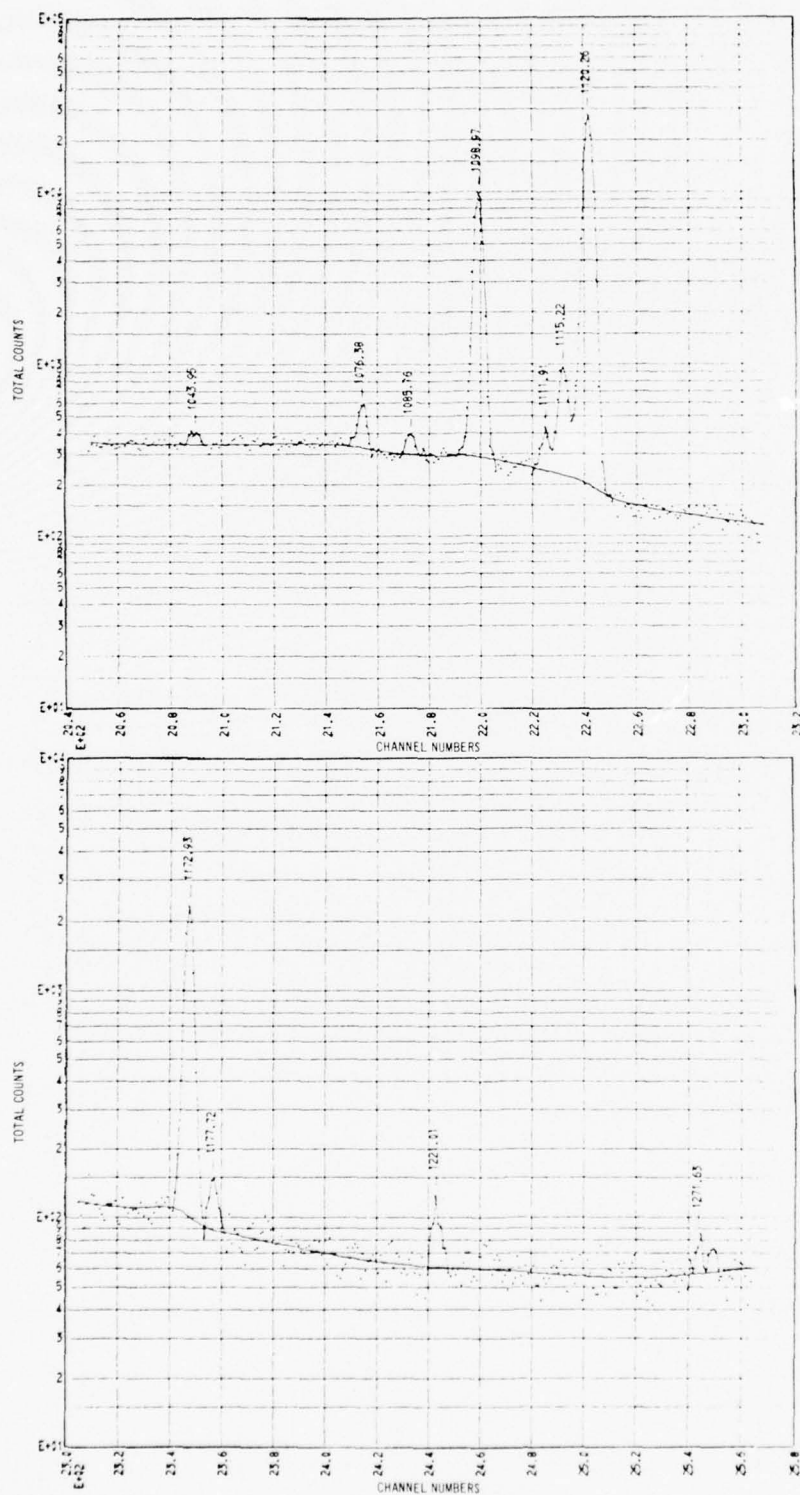


Figure 3. (sheet 5 of 8)

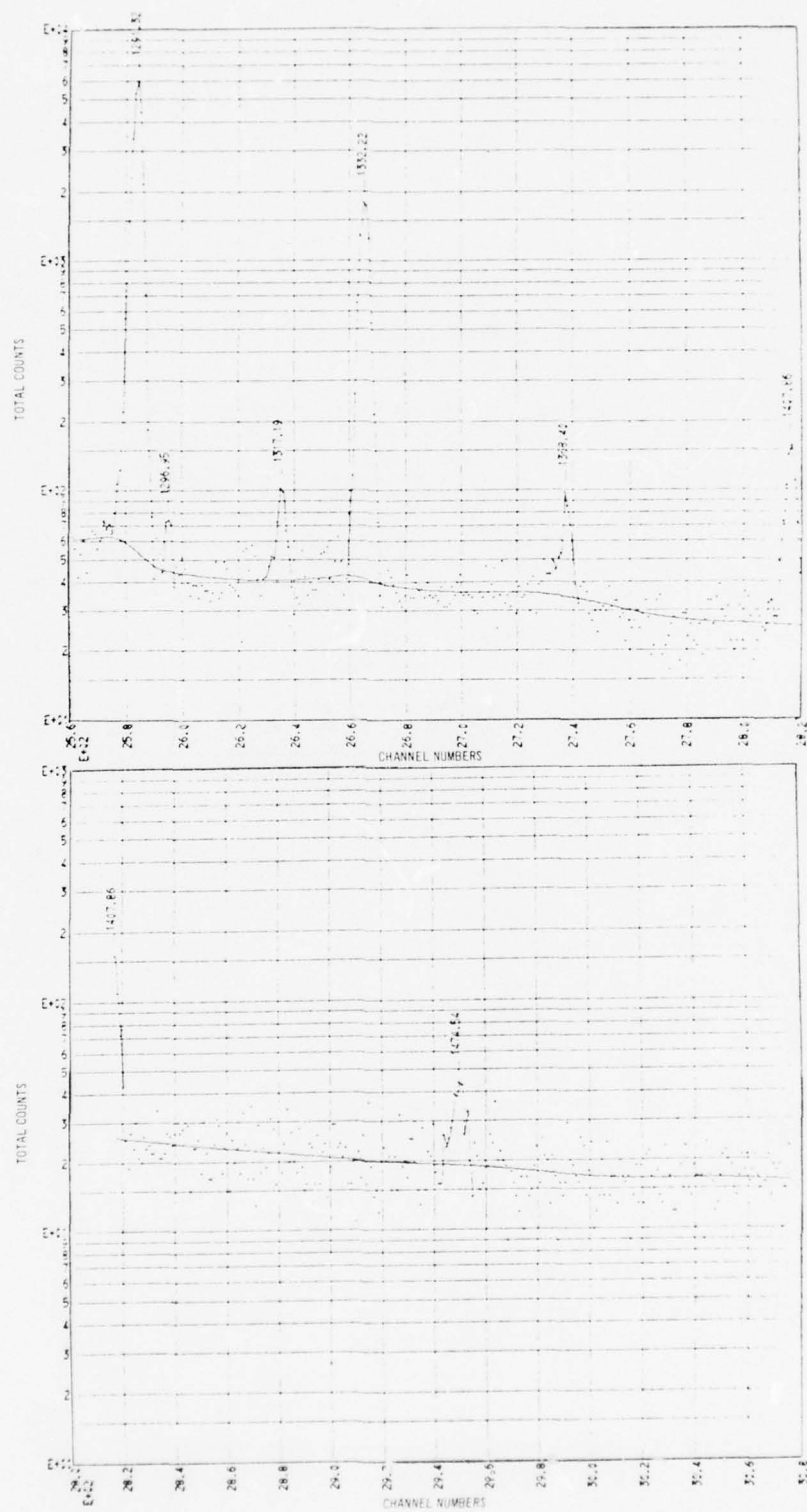


Figure 3. (sheet 6 of 8)

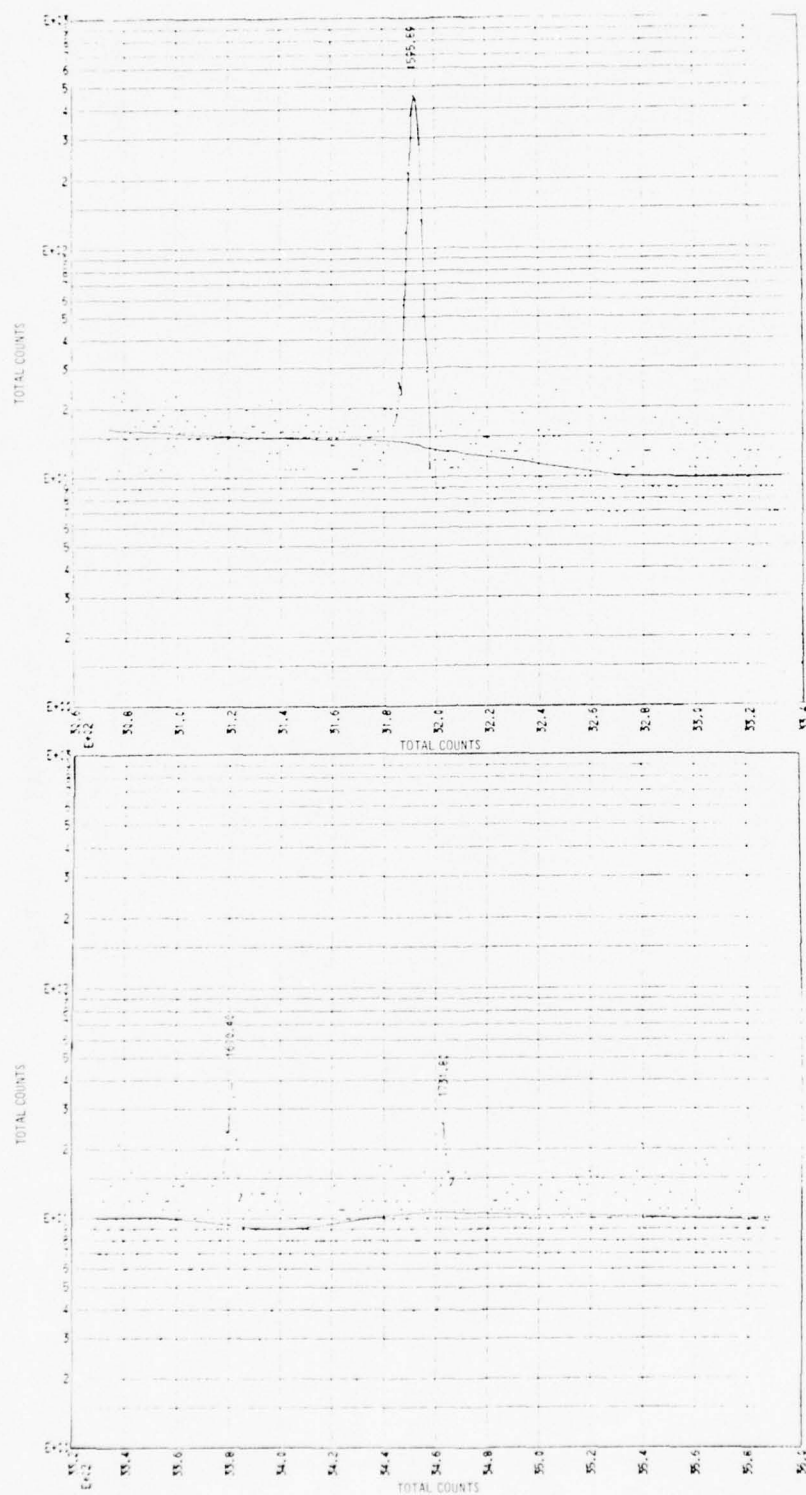


Figure 3. (sheet 7 of 8)

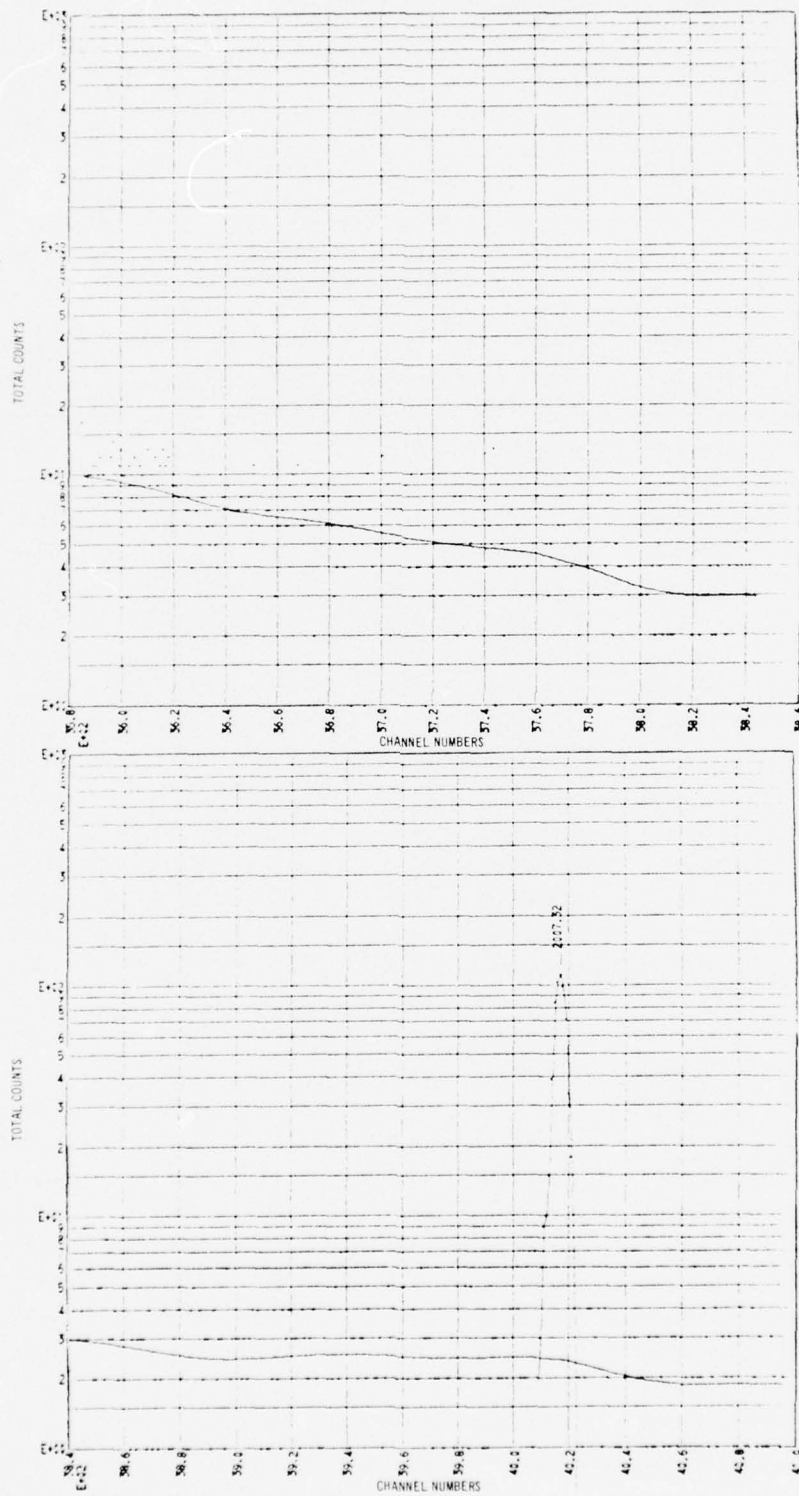


Figure 3. (sheet 8 of 8)

Table 1

Nuclides Identified by the GAMANAL Code

GE Gamma Analysis of 1060 Soil

Experiment No.

Sample Number

Zero Time

129.625

Sample Weight = 1.000E+00

Midtime of Count

142.769

Normalization Weight = 1.000E+00

Decay Time is

13.144 Days

Normalization Factor = 1.000E+00

Geometry is 2.60 CM

Live-Time of Count

66.67 Mins.

(Taken from Channel 1)

MLR Least-Squares Results

Nuclide	Dis/min at Count Time	Dis/min at Zero Time	Atoms at Zero Time	Percent Error	Set No.	Qrit*	Identification Confidence
							Value
SC 46	4.748E+05	5.293E+05	9.224E+10	1.2	1	3.9	0.96
CR 51	3.584E+05	4.976E+05	2.866E+10	2.2	1	3.9	0.77
MN 54	1.424E+04	1.466E+04	9.511E+09	6.1	2	1.0	0.64
FE 59	2.850E+05	3.496E+05	3.239E+10	1.3	1	3.9	1.00
CO 58	4.481E+03	5.092E+03	7.541E+08	25.7	1	3.9	0.81
CO 60	4.003E+04	4.022E+04	1.606E+11	2.3	1	3.9	0.90
ZN 65	2.445E+04	2.538E+04	1.292E+10	8.1	1	3.9	0.72
BR 82	4.721E+03	2.320E+06	7.085E+09	7.7	3	1.0	1.00
RB 86	4.934E+04	8.039E+04	3.116E+09	11.3	4	1.0	0.58
MU 99	4.806E+02	1.317E+04	7.528E+07	20.8	5	1.0	0.36
RU 103	3.514E+03	4.423E+03	3.838E+08	10.9	6	1.0	0.41
SB 122	3.600E+03	9.769E+04	5.600E+08	16.2	7	1.0	0.40
SB 124	1.552E+03	1.806E+03	2.261E+08	18.0	7	1.0	0.15
SB 420	7.578E+02	3.645E+03	4.391E+07	68.9	1	3.9	0.24
TE 132	6.955E+02	1.157E+04	7.788E+07	68.2	1	3.9	0.54
CS 134	5.913E+03	5.985E+03	9.261E+09	9.0	7	1.0	0.97
BA 140	1.218E+04	2.482E+04	6.598E+08	4.8	1	3.9	1.00
CE 141	1.433E+04	1.898E+04	1.277E+09	1.9	8	1.0	0.74
ND 147	4.225E+03	9.643E+03	2.211E+08	43.7	1	3.9	0.77
SM 153	3.812E+04	4.175E+06	1.682E+10	6.3	1	3.9	0.89
EU 152	1.510E+04	1.513E+04	1.608E+11	5.3	1	3.9	1.00
TB 160	5.844E+03	6.631E+03	9.931E+08	16.4	1	3.9	0.68
TM 160	1.662E+03	1.832E+03	3.543E+08	51.0	1	3.9	0.29
LS 177	2.519E+04	9.954E+04	1.371E+09	19.0	1	3.9	0.87
HF 181	1.517E+04	1.881E+04	1.658E+09	3.7	1	3.9	1.00
TA 182	3.674E+03	3.977E+03	9.498E+08	17.8	1	3.9	0.99
AU 199	6.271E+03	1.131E+05	7.399E+08	15.4	1	3.9	0.32
PA 233	2.658E+04	3.725E+04	2.089E+09	4.3	1	3.9	1.00
NP 239	7.722E+03	3.709E+05	1.813E+09	13.3	1	3.9	0.98
AM 241	4.971E+03	4.972E+03	1.634E+12	50.3	1	3.9	0.29

\* Measure of reliability.

were analyzed by the University of California, Berkeley, Nuclear Engineering Reactor Laboratory. Table 2\* presents the results of this analysis obtained from a series of thermal neutron activation experiments. The quantities of 51 neutron-activable elements in parts per million (ppm) of dried sediments were determined. Additional analyses of iridium and rare earth elements in the Bay sediments were performed by the Department of Nuclear Engineering, North Carolina State University at Raleigh, North Carolina. Their measured concentrations are shown in Table 3.\*\*

19. It will be noted that the iridium concentration reported in Table 2 differs from that in Table 3. This difference is believed to have resulted from iridium contamination in the sample provided to North Carolina State. Additional analyses, to be discussed later, were conducted to resolve this difference.

#### Identification of Potential Tracer Elements

20. With the gamma-ray spectrum and approximate concentration of the naturally occurring neutron-activable elements in Bay sediments known, identification of candidate chemical element tracers was accomplished by examining the neutron activation products of all stable chemical elements. In turn, these activation products were examined for their detectability by gamma-ray spectrometry and their physical and chemical properties (half-life, gamma-ray energy, and chemical valence).

21. H. P. Yule<sup>6</sup> has experimentally determined the gamma-ray photopeak yields and limits of detection for 118 reactor thermal neutron products of all elements from oxygen through lead, except for Ne, Kr, and Xe. His work was accomplished with a 1-hr irradiation in a flux of  $4.3 \times 10^{10}$  n/(cm<sup>2</sup> × sec) using an instrumental analysis (76.2- × 76.2-mm (3- × 3-in.) solid thallium-activated sodium iodide NaI (Tl)

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\* Memo: Messrs. C. Cann and Tek Lim, University of California, to E. Leahy, EERL, dated 19 Feb 1974.

\*\* North Carolina State University, Nuclear Energy Services Activation Analysis, Report No. 50961, dated 7 Feb 1974.

Table 2

Concentrations of Major Constituent and Trace Elements in Mare Island  
Sediments in Parts Per Million of Dried Sediments\*

Major		Trace	
Al	35000 $\pm$ 3500	Zn	410 $\pm$ 60
Mg	22000 $\pm$ 2300	Cu	350 $\pm$ 170
Na	19500 $\pm$ 200	Mn	300 $\pm$ 40
K	16000 $\pm$ 1600	Br	220 $\pm$ 20
Fe	5800 $\pm$ 600	Ba	200 $\pm$ 50
Ca	4000 $\pm$ 500	V	68 $\pm$ 7
Cl	2100 $\pm$ 200	Cr	25 $\pm$ 3
Ti	2100 $\pm$ 220	Rb	20 $\pm$ 3
		I	15 $\pm$ 2
		As	10.7 $\pm$ 1.3
		Ga	10 $\pm$ 2
		Ce	5.8 $\pm$ 0.7
		Co	3.5 $\pm$ 0.4
		Sc	3.2 $\pm$ 0.3
		La	2.6 $\pm$ 0.3
		Sm	1.4 $\pm$ 0.4
		Eu	1.2 $\pm$ 0.2
		Cs	1.1 $\pm$ 0.2
		Tm	1.1 $\pm$ 0.2
		W	0.7 $\pm$ 0.2
		Sb	0.64 $\pm$ 0.11
		Yb	0.6 $\pm$ 0.1
		Th	0.52 $\pm$ 0.06
		Hf	0.50 $\pm$ 0.06
		Ho	0.23 $\pm$ 0.03
		Lu	0.21 $\pm$ 0.03
		Mo	<170
		Pd	<160
		Ge	<110
		Nb	<30
		Te	<19
		Hg	<7
		Ni	<6
		Cd	<5
		Os	<0.6
		Zr	<0.5
		Pt	<0.2
		Ag	<0.2
		Se	<0.15
		Ta	<0.06
		In	<0.007
		Au	<0.003
		Ir	<0.0005

\* As determined by the Nuclear Engineering Reactor Laboratory, University of California, Berkeley.

Table 3  
Rare Earth Sensitivities\* and Concentrations\*\*

Isotope	Irradiation Time	Decay Time	Sensitivity	ppm Found in Dry Mud
Ir-192	4 hr	50 days	5 ppb	0.005 $\pm$ 0.002
Tb-160	4 hr	40 days	300 ppb	0.04 $\pm$ 0.01
Eu-152M	10 min	10 hr	700 ppb	< 0.7
Ho-166	4 hr	6 days	250 ppb	< 0.3
Sm-153	4 hr	6 days	200 ppb	1.57 $\pm$ 0.09
Gd-159	4 hr	6 days	1 ppm	< 1.0
Lu-177	4 hr	20 days	250 ppb	< 0.3

\* Sensitivities are calculated on the basis of the activity of a standard superimposed on the activity in the mud (i.e., a spiked mud sample) with all experimental parameters identified.

\*\* As determined by Department of Nuclear Engineering, North Carolina State University at Raleigh, North Carolina.

crystal and no interfering elements). This work was selected for screening the neutron-activable elements since it was conducted with a reactor thermal neutron flux which is available at a reasonable cost per reactor hour. The General Atomics TRIGA reactor used by Yule also permits irradiation of large numbers of samples at one time. Other reactor facilities do exist which will permit sample irradiation in a variety of modes, but none were found that allowed processing the number of samples envisioned at the low dollar value possible in the TRIGA type reactor.

22. In reviewing the thermal neutron activation products listed by Yule, the following operational factors were considered in selecting the candidate chemical elements to be considered as tracers:

- a. Since several thousand samples were to be irradiated, a TRIGA type reactor would be used because it permits 40 or more samples to be irradiated in a single batch.

- b. To prevent contamination of the reactor facility, samples for irradiation would be encapsulated in sealed aluminum containers within a secondary irradiation capsule. For safety consideration, the radioactivity generated in the sample plus that generated in the aluminum container would require a 48-hr cooling time before removal of the samples from the reactor to permit short half-life nuclides to decay. Considering transportation time, approximately 60 hr would elapse before sample examination could commence.
- c. The mode and operational cycle of the dredge dictated the quantity and time at which the tracer could be introduced. In its normal operational mode, the dredge filled its hoppers and overflowed an amount of material until a maximum load was acquired. Its cycle time from channel clearance to arrival at the dump site was approximately 20 min. Thus, to prevent inadvertent contamination of the channel, tagged sediments would have to be added after the dredge cleared the channel. The physical facilities for sediment tagging and the logistics and time constraint of adding the tagged material to the dredge's hoppers limited the total tagged sediment that could be employed to approximately  $9.1 \times 10^6$  g (20,000 lb).
- d. The tracer must be detectable after dilution in the Bay by the anticipated load of sediment with which the tagged dredge material might mix. Approximately  $1.5 \times 10^6$  m<sup>3</sup> ( $2 \times 10^6$  yd<sup>3</sup>) or a mass of approximately  $6 \times 10^{11}$  g ( $1.3 \times 10^9$  lb) were to be dredged assuming 448.3-kg/m<sup>3</sup> (28-lb/ft<sup>3</sup>) in-place dry density. This mass could be further mixed with approximately  $7.6 \times 10^6$  m<sup>3</sup> ( $1 \times 10^7$  yd<sup>3</sup>) of sediments or  $3.4 \times 10^{12}$  g ( $7.5 \times 10^9$  lb), the estimated yearly influx of sediments to the San Francisco Bay.<sup>4</sup>
- e. The gamma-ray energy of the tracer was desired to be as high as possible to maximize the signal-to-noise ratio. The low-energy regions of the gamma-ray spectra are harder to analyze than the high-energy regions.

23. The above operational factors resulted in criteria for selecting candidate tracers as follows:

- a. The tracer half-life should be sufficiently long to insure the signal would not be significantly degraded through radioactive decay during the time from neutron activation to sample examination.
- b. The quantity of tracer employed must be fixed to approximately  $9.1 \times 10^6$  g (20,000 lb) of sediment without altering the sediment's settling characteristics. For screening purposes, the authors established that the mass of

tracer to be used could not exceed 1 percent of the mass to be tagged or 0.010 g tracer/g of sediment (g/g).

- c. The tracer must be detectable after the mixing of the tagged sediments with the estimated yearly influx of sediments,  $3.4 \times 10^{12}$  g.

24. Using the above criteria, the radionuclides listed in Table 4 were examined, and each radionuclide was rated as to its potential for use as a tracer. The data in Table 4, except for the concentration of elements in the sediments, are from Reference 6. Element concentrations are from Tables 2 and 3.

25. In the minimum detection range of  $10^{-5}$  to  $10^{-4}$   $\mu\text{g}$ , only gold ( $^{198}\text{Au}$ ) was a possible tracer. All other elements were rejected because of their short half-life or high natural abundance in the Bay sediments. As an example, at 60 hr postirradiation time the signal, gamma-ray emission rate, from Europium ( $^{152\text{m}}\text{Eu}$ ) with a 9.3-hr half-life would be reduced by radioactive decay to about 1.1 percent of its original value. In addition, to add sufficient Eu to the Bay sediments being dredged to increase the Eu content by a factor of 10 would require  $7 \times 10^7$  g (154,000 lb)--more mass than the  $9.1 \times 10^6$  g (20,000 lb) to be tagged.

26. In the minimum detection range of  $10^{-4}$  to  $10^{-3}$   $\mu\text{g}$ , only rhenium ( $^{188}\text{Re}$ ) and iridium ( $^{194}\text{Ir}$ ) were possibly suitable, and both were rejected because of their short half-lives which by 60 hr postirradiation time would reduce their signals to less than 12 percent of their values at the end of neutron activation.

27. In the minimum detection range of  $10^{-3}$  to  $10^{-2}$   $\mu\text{g}$ , rhenium ( $^{186}\text{Re}$ ) and iridium ( $^{192}\text{Ir}$ ) were selected as possible tracers. Their long half-lives ( $^{186}\text{Re}$ , 90 hr and  $^{192}\text{Ir}$ , 74.4 days) would produce suitable signals after 60 hr of decay.

28. The nuclides with detection ranges between  $10^{-2}$  and  $10^{-1}$   $\mu\text{g}$  were also examined, and tantalum ( $^{182}\text{Ta}$ ) and terbium ( $^{160}\text{Tb}$ ) were identified as possible tracers.

29. With the possible candidate tracer elements identified, each element was examined to determine which was the most suitable in terms of technically satisfying the task objectives while minimizing cost. Table 5 lists the elements, radionuclide of interest, certain physical

Table 4  
Minimum Detection Range of Reactor Thermal Neutron Products

Minimum Detection Range ug	Nuclide	Half-life	Energy MeV	Concentration ppm of Dried Sediment	Useful Traces*
10 <sup>-5</sup> to 10 <sup>-4</sup> ↓	<sup>56</sup> Mn	2.58 hr	0.84	300	No - 1
	<sup>116m</sup> In	54 min	1.27	0.007	No - 1
	<sup>128</sup> I	25 min	0.455	15	No - 1
	<sup>198</sup> Au	2.70 days	0.411	0.003	Possible
	<sup>152m</sup> Eu	9.3 hr	0.961	1.2	No - 1, 3
	<sup>165</sup> Dy	75 sec	0.108	--	No - 1
	<sup>165</sup> Dy	2.3 hr	0.94	--	No - 1
10 <sup>-4</sup> to 10 <sup>-3</sup> ↓	<sup>41</sup> Ar	1.83 hr	1.29	--	No - 1
	<sup>46m</sup> Sc	20 sec	0.140	3.2	No - 1
	<sup>52</sup> V	3.76 min	1.44	68	No - 1
	<sup>82</sup> Br	1.5 days	0.55 + 0.63	220	No - 2, 3
	<sup>134m</sup> Cs	2.9 hr	0.127	1.1	No - 1
	<sup>180m</sup> Hf	5.5 hr	0.216	0.5	No - 1
	<sup>188</sup> Re	16.7 hr	0.155	--**	No - 1
	<sup>194</sup> Ir	19.0 hr	0.328	< 0.0005	No - 1
	<sup>153</sup> Sm	1.94 days	0.102	1.4	No - 3
	<sup>166</sup> Ho	27.3 hr	0.080	0.23	No - 1
	<sup>171</sup> Er	7.5 hr	0.301	--	No - 1
10 <sup>-3</sup> to 10 <sup>-2</sup> ↓	<sup>24</sup> Na	15 hr	1.37	19,500	No - 3
	<sup>28</sup> Al	2.3 min	1.78	35,000	No - 1
	<sup>60m</sup> Co	10.5 min	0.059	3.5	No - 1

(Continued)

- \* 1. Half-life too short.  
 2. Undesirable chemical characteristics.  
 3. Natural abundance in the Bay sediments.  
 \*\* Estimated to be about 0.001 ppm.

(Sheet 1 of 3)

Table 4 (Continued)

Minimum Detection Range $\mu\text{g}$	Nuclide	Half-life	Energy MeV	Concentration ppm of Dried Sediment	Useful Traces
$10^{-3}$ to $10^{-2}$ ↓	$^{64}\text{Cu}$	12.8 hr	0.51	350	No - 3
	$^{72}\text{Ga}$	14.3 hr	0.834	10	No - 3
	$^{76}\text{As}$	1.10 days	0.555	10.7	No - 3
	$^{81\text{m}}\text{e}$	61 min	0.104	0.15	No - 1
	$^{87\text{m}}\text{Sr}$	2.8 hr	0.388	--	No - 1
	$^{104\text{m}}\text{Rh}$	4.4 min	0.556	--	No - 1
	$^{108}\text{Ag}$	24 sec	0.656	0.2	No - 1
	$^{110\text{m}}\text{Ag}$	2.3 min	0.630	0.2	No - 1
	$^{111\text{m}}\text{Cd}$	49 min	0.24	< 5	No - 1
	$^{122}\text{Sb}$	2.8 days	0.566	0.64	No - 3
	$^{139}\text{Ba}$	83 min	0.163	200	No - 3
	$^{187}\text{W}$	1.0 days	0.482	0.7	No - 3
	$^{140}\text{La}$	40.2 hr	1.60	2.6	No - 3
	$^{149}\text{Nd}$	1.8 hr	0.211	--	No - 1
	$^{159}\text{Gd}$	18.5 hr	0.364	< 1.0	No - 1
	$^{177}\text{Yb}$	1.9 hr	0.147	0.6	No - 1
	$^{177}\text{Lu}$	6.8 days	0.208	0.21	No - 3
	$^{192}\text{Ir}$	74.4 days	0.316	< 0.0005	Possible
	$^{186}\text{Re}$	90 hr	0.137	-- **	Possible
$10^{-2}$ to $10^{-1}$ ↓	$^{38}\text{Cl}$	37.3 hr	1.64	2,100	No - 1, 3
	$^{42}\text{K}$	12.5 hr	1.53	16,000	No - 1, 3
	$^{115}\text{Cd}$	54 hr	0.335	< 5	No - 3
	$^{123}\text{Sn}$	41 min	0.153	--	No - 1
	$^{124}\text{Sb}$	60 days	0.603	0.64	No - 3

(Continued)

\*\* Estimated to be about 0.001 ppm.

(Sheet 2 of 3)

Table 4 (Concluded)

Minimum Detection Range $\mu\text{g}$	Nuclide	Half-life	Energy MeV	Concentration ppm of Dried Sediment	Useful Traces
$10^{-2}$ to $10^{-1}$ ↓	$^{51}\text{Ti}$	5.8 min	0.32	2,100	No - 1, 3
	$^{69\text{m}}\text{Zn}$	13.8 hr	0.44	410	No - 1, 3
	$^{76}\text{Ge}$	1.4 hr	0.264	< 110	No - 1, 3
	$^{86\text{m}}\text{Rb}$	1.0 min	0.56	20	No - 1, 3
	$^{97}\text{Zr}$	17 hr	0.750	< 0.5	No - 1
	$^{101}\text{Mo}$	14.6 min	0.191	< 170	No - 1
	$^{99}\text{Mo}$	66 hr	0.141	< 170	No - 1
	$^{108}\text{Ru}$	4.5 hr	0.72	--	No - 1
	$^{109\text{m}}\text{Pd}$	48 hr	0.19		
	$^{109}\text{Pd}$	13.6 hr	0.088	160	No - 1
	$^{131}\text{Te}$	25 min		19	No - 1
	$^{182}\text{Ta}$	115 days	1.122 + 1.222	0.06	Possible
	$^{182\text{m}}\text{Ta}$	16 min	0.147 + 0.172 + 0.184	0.06	No - 1
	$^{199}\text{Pt}$	30 min	0.318	0.2	No - 1
	$^{197\text{m}}\text{Hg}$	24 hr	0.133	7	No - 1
	$^{143}\text{Ce}$	1.37 days	0.294	5.8	No - 1
	$^{142}\text{Pr}$	19 hr	1.57	--	No - 1
	$^{160}\text{Tb}$	73 days	0.299	0.04	Possible

(Sheet 3 of 3)

Table 5

## Candidate Tracer Elements

Element	Nuclide	Half-Life	Limit of Detection g	Abundance in Sediments g/g	Tracer Required* g	Unit Cost \$/g	Total Cost**
Gold	$^{198}\text{Au}$	2.7 Days	$7.0 \times 10^{-11}$	$3 \times 10^{-9}$	$1 \times 10^5$	3.85	\$ 392,700
Rhenium	$^{186}\text{Re}$	90 Hours	$2.1 \times 10^{-9}$	$1 \times 10^{-9}$	$3.4 \times 10^4$	1.28- 4.40	43,800- 136,000
Iridium	$^{192}\text{Ir}$	74.37 Days	$1.0 \times 10^{-9}$	$5 \times 10^{-10}$	$1.7 \times 10^4$	8.00	136,000
Tantalum	$^{182}\text{Ta}$	115 Days	$4.8 \times 10^{-8}$	$6 \times 10^{-4}$	$2 \times 10^9$	0.03	1,000,000
Terbium	$^{160}\text{Tb}$	73 Days	$2.8 \times 10^{-8}$	$3 \times 10^{-4}$	$1.0 \times 10^9$	3.00	1,000,000

\* To exceed quantity naturally occurring in  $3.4 \times 10^{12}$  g of sediment.

\*\* Except for iridium and gold, cost data were taken from the Handbook of Chemistry and Physics, 53rd edition, 1972-1973. Iridium had been purchased for \$6.95/g and was estimated to inflate to \$8.00/g. The market price for gold was \$120.00/troy ounce (31.10348 g/troy ounce) and was fluctuating. Rhenium's price was also fluctuating.

characteristics, quantity required, and estimated cost. The amount of element required is the amount necessary to exceed by a factor of 10 the quantity of that chemical element naturally occurring in the  $3.4 \times 10^{12}$  g of sediment assumed as the annual sediment load with which the traced dredged material could mix.

30. From Table 5, it can be seen that gold, rhenium, and iridium were the only suitable chemical element candidates considering cost and the quantity of tracer that could be placed on the  $9.1 \times 10^6$  g (20,000 lb) of sediment to be tagged. Each of the chemical elements had no chemical characteristics which would prohibit their use as a chemical element tag.

31. For the three candidate tracer elements, Table 6 indicates the concentration on the sediments to be tagged, the concentration in the dredged material at the time of release, and the possible concentration in samples to be collected assuming dilution occurs by the estimated yearly influx of sediments into the Bay.

32. With the possible concentrations of each tracer element determined for the samples to be collected from the Bay, analysis methods were investigated to determine the candidate element based on minimum overall cost (tracer purchase price plus analysis cost) and maximum tracing sensitivity.

#### Methods of Sample Analysis

##### Direct sample examination

33. As previously noted, the detection limits stated by Yule<sup>6</sup> were for an instrumental analysis when no interfering elements were present. To determine the detection limits for a lithium-drifted germanium diode, Ge(Li), system, 1-g samples of sediments were spiked with various concentrations of each candidate element and neutron-activated. The trace element concentrations employed were equal to those shown in Table 6 for the dredged material at the time of release and after dilution by the assumed sediment inflow to the Bay.

34. Examination of these samples at postirradiation times from

Table 6  
Concentration of Trace Elements in Tagged Dredged  
Materials and Bay Samples

Element	Nuclide	Tracer Quantity g	Concentration on Sediments to be Tagged* g/g	Concentration in Sediments at Dump Time** g/g	Possible Concentration in Samples Collected After Dilution† g/g
Gold	$^{198}\text{Au}$	$1 \times 10^5$	$1.1 \times 10^{-2}$	$1.6 \times 10^{-7}$	$2.9 \times 10^{-8}$
Rhenium	$^{186}\text{Re}$	$3.4 \times 10^4$	$3.7 \times 10^{-3}$	$5.6 \times 10^{-8}$	$1 \times 10^{-8}$
Iridium	$^{192}\text{Ir}$	$1.7 \times 10^4$	$1.8 \times 10^{-3}$	$2.8 \times 10^{-8}$	$5 \times 10^{-9}$

\*  $9.1 \times 10^6$  g (20,000 lb) to be tagged.

\*\* Assuming  $1.5 \times 10^6 \text{ m}^3$  ( $2 \times 10^6 \text{ yd}^3$ ) containing  $6 \times 10^{11}$  g to be dredged.

† Assuming dilution by  $7.6 \times 10^6 \text{ m}^3$  ( $1 \times 10^7 \text{ yd}^3$ ) containing  $3.4 \times 10^{12}$  g of sediment.

60 hr to 30 days indicated that a suitable signal-to-noise ratio could not be obtained. At early postirradiation times, the short-lived nuclides resulting from the naturally present elements in the sediments masked the trace elements' signals. At later times, radioactive decay reduced the gold and rhenium signals. Iridium could be detected, but the signal-to-noise ratio was not satisfactory below  $1 \times 10^{-8}$  g Ir/g of sediment. Thus, examination of the gross spectra was not feasible and chemical separations were indicated since, from Table 6, a detection sensitivity of at least  $1 \times 10^{-9}$  g Ir/g of sediment is required.

Chemical and radio-  
chemical separation techniques

35. To separate the trace elements from the sediments so that an instrumental analysis without the interference of other elements could be performed, chemical separation using dissolution and precipitation methods, radio-chemical separation using dissolution and carrier separation, and fire assay procedures were investigated with the following results:

- a. Chemical separation is not possible since the quantity of tracer materials even in a large volume sample is too low to precipitate.
- b. Radio-chemical separations are possible using dissolution and carrier separations. However, they were judged to be costly because of the amount of material that had to be irradiated, the safety measures required for handling the radioactivity, the need for time scheduling of operations to minimize the decay of the short half-life nuclides of gold and rhenium, and the difficulty of dissolving the sediments.
- c. Fire assay procedures were found to be feasible and less costly. Fire assay is a process routinely used in the assay of ores for noble metals. Briefly, in the fire assay process finely divided ore is mixed with lead oxide, a reducing agent such as starch, and fluxing materials, sodium carbonate and borax. This mixture is heated until it melts. Upon melting, the mixture separates into two liquid phases with the ore staying on top in a slag phase and with the noble metals plus a few other elements contained in the heavy metallic lead phase on the bottom.

36. The fire assay process can be performed on the Bay sediment samples prior to neutron activation and thus permits the use of a large

mass (up to 100 g) of sediment material. It effectively concentrates the elements of interest plus a few unwanted elements from the large sediment mass while eliminating many elements which produce undesirable noise in a sample being counted.

37. Figure 4 presents the gamma-ray spectra of a neutron-activated sediment sample in curve 1 and the spectra after the same sediment was fire-assayed and the iridium collected in a metallic lead pellet in curve 2. Both spectra were measured at the same postirradiation time of 9 days. From the figure, it can also be seen that most of the photon peaks in the sediment sample (curve 1) are absent in the lead pellet (curve 2), that the noise level curve 2 is reduced over its entire energy range, and that the iridium photon peaks (0.316 and 0.468 MeV) are more clearly defined in curve 2.

38. There are methods of separating the noble elements from the lead by cupellation, but these add costs; and our experimental evidence indicated unacceptable losses of the iridium.

#### Selection of Tracer Element

39. As previously indicated, the candidate tracer elements were gold, rhenium, and iridium. On a cost basis, since each was amenable to the fire assay process, gold was eliminated as a potential tracer due to its high initial purchase cost. From the above evidence, fire assay was judged to be not only satisfactory but also necessary to measure low-iridium concentration sediments.

40. Iridium and rhenium were further investigated to determine which element was the most suited to the task from technical and cost considerations. In Table 5, the cost to accomplish the tracing operation for rhenium is indicated to be from \$43,800 to \$136,000 depending on the cost information source, and the iridium cost was estimated to be \$136,000. Taking the lower value, rhenium's initial cost is one-third that of iridium, but in the fire assay process and spectral resolution rhenium presents certain technical problems due to its low gamma-ray energy of 0.137 MeV and its 90-hr half-life.

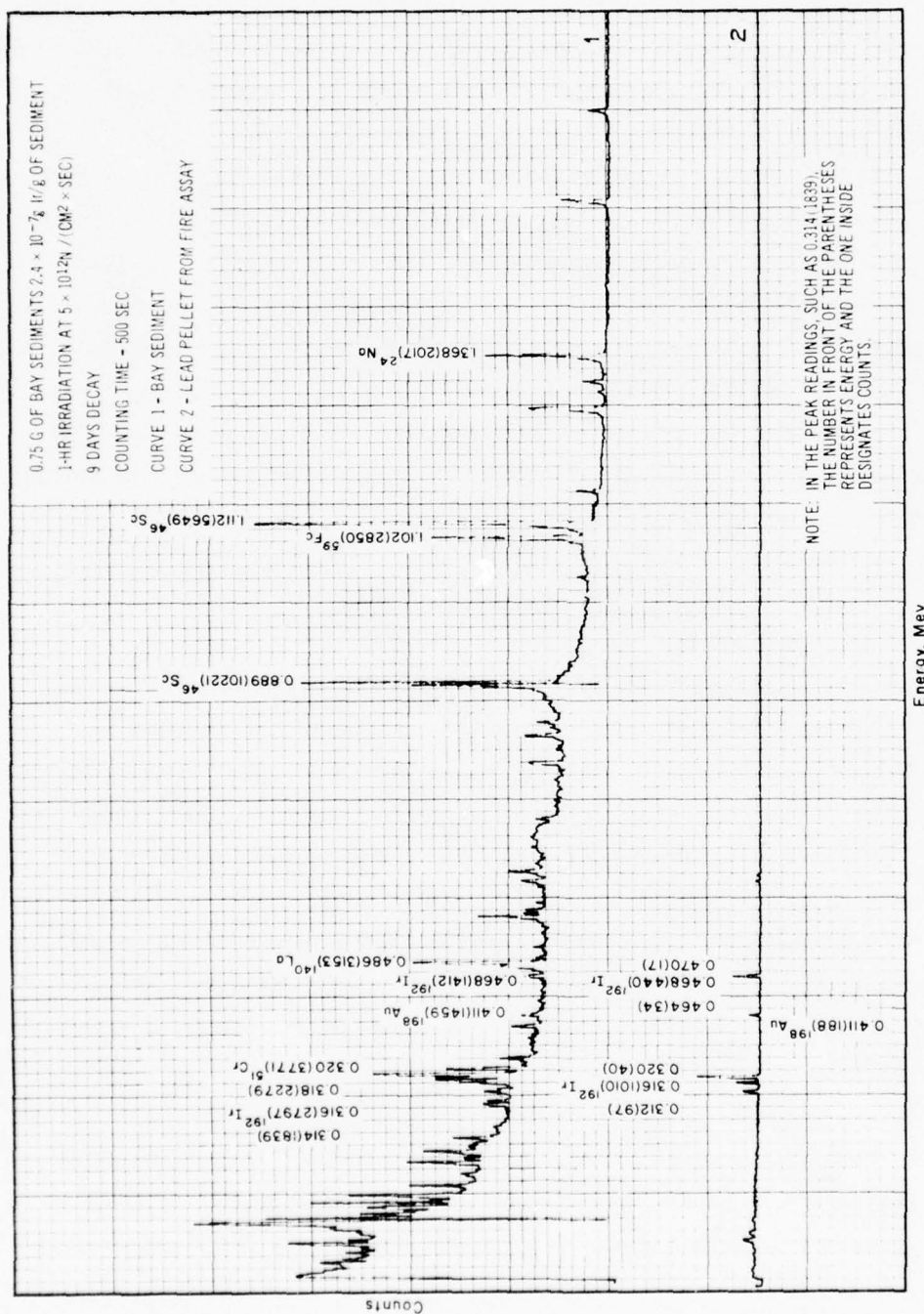


Figure 4. Spectra of iridium-traced San Francisco Bay sediment and fire assay lead pellet from similar sediment

41. The low gamma-ray energy places the rhenium signal in the portion of the spectra which has a high noise level due to the Compton scattered gamma rays from other emitters. While the fire assay process removes most interfering radionuclides, many nuclides from the sediment and from the fire assay chemicals such as silver, lead, and sodium, among others, contribute to Compton scattering and result in noise in the 0.137-MeV region.

42. An additional problem is the gamma-ray emission from selenium ( $^{75}\text{Se}$ ) with a 120-day half-life and a gamma-ray energy of 0.136 MeV. The  $^{75}\text{Se}$  comes from both the sediments and the chemicals used in the fire assay process and would interfere with the resolution of the rhenium signal.

43. The signal from rhenium also decays too fast, and at 60-hr postirradiation it would be reduced to 60 percent; at 6 days, to 33 percent; and at 11 days, to 13 percent. To provide an acceptable signal at 6 days and beyond when the interference from  $^{24}\text{Na}$  diminishes, the amount of rhenium tracer and thus the cost would have to be increased by at least a factor of 3 or more.

44. By contrast, iridium with a 74.37-day half-life and a principal gamma ray emitted at 0.316 MeV does not exhibit the above-mentioned problems. The higher gamma-ray energy of iridium is in an area of the spectrum little influenced by noise, and its half-life will permit delaying the time of sample counting until the short half-life nuclides in the recovered lead have decayed. No other element directly interferes with the detection of the iridium's 0.316-MeV gamma ray.

45. Thus, it was concluded that iridium was the better choice as a tracer both on the basis of cost and on technical considerations. Iridium's principal attributes as a tracer are summarized below:

- a. The amount of iridium required minimizes the mass that must be added to the traced sediment and therefore would least affect particle settling characteristics.
- b. The limit of detection for iridium is a factor of 2 lower than that for rhenium.
- c. The 74.37-day half-life permits examination of neutron-activated samples at significantly ~~long~~ postirradiation

time without significant reduction in signal due to radioactive decay.

#### Quantity of Iridium to be Employed

46. The criteria for selecting the tracer element included the assumptions that the natural content of the selected element in the yearly sediment load should be exceeded by a factor of 10 and that  $9.1 \times 10^6$  g (20,000 lb) of sediment material would be tagged. Prior to purchase of the tracer element these assumptions were reexamined considering the sampling system to be employed. The objective was to determine if the quantity of material to be tagged was sufficient and if the cost\* of the tracer could be reduced.

47. San Francisco District personnel during previous sampling efforts had determined the maximum size core sample of the Bay sediments that could be reliably retrieved was 54 mm (2-1/8 in.) in diameter. Using this core diameter and the surface area of the test area, the following calculations were performed to determine if sufficient particulate matter was to be tagged.

48. The test area consisting of San Pablo, Suisun, and Grizzly Bays, plus Mare Island Strait, is approximately  $3.16 \times 10^8$  m<sup>2</sup> (92 square nautical miles). From examination of sediment samples from this test area, it was determined that the mean particle diameter is between 14 and 20 microns. Assuming all particles (p) are 20 microns in diameter, then the volume (V) of one particle is

$$V = \left(\frac{4}{3}\right)(3.14)(1 \times 10^{-3} \text{ cm})^3 = 4.18 \times 10^{-9} \text{ cm}^3$$

Assuming a specific density of 2.6 g/cm<sup>3</sup> for p, then the weight (W) of one particle is

---

\* Inflation, devaluation of the dollar, increased industrial demand, and a general withholding from the market by producers outside of the United States eventually increased the price of iridium from \$6.95/g to \$18.00/g at purchase time.

$$W = \left( 2.6 \frac{\text{g}}{\text{cm}^3} \right) (4.18 \times 10^{-9} \text{ cm}^3) = 1.08 \times 10^{-8} \text{ g}$$

49. In  $9.08 \times 10^6 \text{ g}$  (20,000 lb), there are

$$\left( \frac{1}{1.08 \times 10^{-8}} \right) \frac{\text{p}}{\text{g}} (9.08 \times 10^6 \text{ g}) = 8.4 \times 10^{14} \text{ p}$$

Assuming uniform particle distribution over the test area of  $3.15 \times 10^8 \text{ m}^2$ , the result is:

$$\frac{8.4 \times 10^{14} \text{ p}}{3.15 \times 10^8 \text{ m}^2} = 2.67 \times 10^6 \frac{\text{p}}{\text{m}^2}$$

Assuming the material from the dredge is uniformly deposited and not mixed in depth a sample with a 25.4-mm (1-in.) radius has an area of  $20.3 \text{ cm}^2$  ( $3.14 \text{ in.}^2$ ). The p/sample is

$$(20.3 \text{ cm}^2) \left( 2.67 \times 10^6 \frac{\text{p}}{\text{m}^2} \right) = 5.3 \times 10^3 \frac{\text{p}}{\text{sample}}$$

With  $1.7 \times 10^4 \text{ g}$  of iridium on  $8.3 \times 10^{14} \text{ p}$ , each p would contain

$$\frac{1.7 \times 10^4 \text{ g Ir}}{8.3 \times 10^{14} \text{ p}} = 2.05 \times 10^{-11} \text{ g } \frac{\text{Ir}}{\text{p}}$$

in a sample. Then the iridium content from the tagged dredged material could be

$$\left( 2.05 \times 10^{-11} \text{ g } \frac{\text{Ir}}{\text{p}} \right) \left( 5.3 \times 10^3 \frac{\text{p}}{\text{sample}} \right) = 1.09 \times 10^{-7} \text{ g } \frac{\text{Ir}}{\text{sample}}$$

If the sample is a 50-g size, the iridium content from nature, assuming  $5 \times 10^{-10} \text{ g Ir/g}$ , would be:

$$\left(50 \frac{\text{g}}{\text{sample}}\right) \left(5 \times 10^{-10} \text{ g } \frac{\text{Ir}}{\text{g}}\right) = 2.50 \times 10^{-8} \text{ g } \frac{\text{Ir}}{\text{sample}}$$

Thus the signal would be four times background or  $1 \times 10^{-7}$  g Ir, which is easily seen in the counting system.

50. Using  $1 \times 10^4$  g of iridium, the iridium content per sample would be

$$6.3 \times 10^{-8} \text{ g } \frac{\text{Ir}}{\text{sample}}$$

which is 2.5 times the background and also readily seen. Thus, it was concluded that: (a)  $9.1 \times 10^6$  g (20,000 lb) were a sufficient amount of material to be tagged; and (b)  $1 \times 10^4$  g of iridium would be sufficient signal and would represent a cost savings of 40 percent on the purchase price of the tracer.

### PART III: THE TAGGING, TRACING, AND DREDGING OPERATIONS

#### Physical Properties of the Sediments

51. As previously indicated, the San Francisco District provided samples of the San Francisco Bay sediments from the 21 locations shown in Figure 2 and samples from the Mare Island Strait during dredging. The particle-size distribution of these sediments was determined and is presented in Table 7. The particle-size analysis utilized nondispersed wet-sieving, liquid-sedimentation, and Tyler sieves.

52. Approximately 30 g of as-received sediment were wet-sieved through a 325-mesh screen (43-micron-diam openings) using water from a wash bottle and a spoon to speed the process by breaking agglomerated lumps. The sieve was rinsed with water until only particles greater than 43 microns were retained. The retained material was prepared for additional sieving by drying for several hours in an oven. Sediment particles less than 43 microns which passed through the sieve with the water during the wet sieving were retained for the liquid-sedimentation analysis.

53. The oven-dried particles greater than 43-micron diameter were transferred to a nest of Tyler sieves and Ro-Tapped for 5 min into 991, 350, 180, 125, 43 microns, and pan fractions (less than 43 microns). The dry particle fractions were weighed, and particles less than 43 microns were added to those from the wet-sieving step.

54. The small particles were sized by liquid sedimentation according to Stokes' Law, which describes the rate of fall of a small sphere in a viscous fluid under the action of gravity as

$$V = \frac{2ga^2(d_1 - d_2)}{9\eta}$$

where

V = constant velocity (cm/sec)

g = gravity (cm/sec<sup>2</sup>)

Table 7  
Sediment Properties

Sample	Location	Solids %	pH <sup>*</sup>	d** μ	NaCl† %
1	Mare Island Strait, NW upper	37.8	7.6	19	1.5
2	Mare Island Strait, NE upper	38.4	7.6	15	2.0
3	Mare Island Strait, Center Channel	31.6	8.2	19	1.5
4	Pinole Shoal Naval Anchor 315	47.9	7.8	20	1.5
5	Mare Island Strait, SW lower	53.3	8.2	19	1.3
6	Mare Island Strait, SE lower	39.4	8.2	19	5.8
7	Dike 9	42.8	8.1	19	1.3
8	Carquinez Strait, below power cables	63.8	8.4	130	1.2
9	North Side Disposal Dike 12	47.7	8.3	70	0.84
10	South Side Disposal Dike 12	46.8	8.0	15	1.8
11	San Pablo Bay Shoal 1st Target N Dike 12	48.5	8.2	15	5.1
12	SW Davis Point	45.1	8.3	19	1.9
13	Carquinez Strait at Selby Toll	44.7	8.2	17	2.1
14	San Pablo Bay 2nd Target Dike 12	40.4	8.2	16	1.9
15	Pinole Shoal Channel Anchor 318	66.3	8.2	180	0.67
16	South Mud Flat Hercules Wharf	49.7	8.1	14	2.1
17	Shallows of San Pablo Bay	45.9	8.3	19	3.9
18	Mud Flats East of Pinole Point	50.6	7.5	14	1.6
19	Mud Flats Shallows San Pablo Bay	43.5	7.8	15	1.4
20	San Pablo Bay 33 <sup>1</sup> / <sub>4</sub> Anchorage	45.2	8.0	16	1.4
21	San Pablo Bay Mud Flats	43.2	7.8	14	1.9
22	Mare Island Strait, sediments from dredge <u>Harding</u>	50.1	7.6	18	1.5

\* pH of 50 g of wet sediments mixed with 50-ml distilled water.

\*\* d is diameter of mean particle. One-half the mass is larger than this nondispersed size.

† Includes all insoluble silver salts calculated as NaCl.

- $a$  = radius of sphere (cm)
- $d_1$  = density of sphere ( $\text{g/cm}^3$ )
- $d_2$  = density of medium ( $\text{g/cm}^3$ )
- $\eta$  = coefficient of viscosity which is temperature dependent ( $\text{dyne-sec/cm}^2$ )

According to Stokes' Law, a particle of 2.65 density and spherical shape will fall through 10 cm of water of a given temperature in the times listed in Table 8.

55. The liquid-sedimentation apparatus is a vacuum-jacketed glass cylinder of 2-l capacity, with a stopcock controlled sampling spout located exactly 10 cm below the 2000-ml volume mark. The subsieve particle analysis consists of adding the water slurry containing the particles less than 43-micron diameter to the sedimentation column and adjusting the volume to the 2000-ml mark. The particles are uniformly dispersed by shaking the column and repeatedly inverting it, and the settling process is started by standing the column upright on the laboratory bench. At any specified time, an aliquot taken from the sampling spout will have only particles less than the predicted size, since the larger particles will have settled past the 10-cm level. Aliquots taken at increasing times can thus be measured to yield a size distribution for particles less than 43 microns in diameter.

56. As an example, it will be noted in Table 7 that it takes 8 min 5 sec for a 15-micron particle to fall 10 cm in a column of 15°C water. In practice, a 10-ml aliquot is withdrawn first to rinse the spout a few seconds prior to the selected time. At exactly 8 min 5 sec, a 10-ml volumetric flask is filled with the slurry containing particles less than 15 microns in diameter. The 10-ml aliquot is rinsed through an 0.8-micron millipore filter, after which the filter is dried to constant weight and the mass of particles determined. The total weight of particles in the column is determined from a 10-ml aliquot taken at essentially zero time before any settling takes place.

57. Although the numerical values in Table 7 are for particle diameters of spherical shape and uniform density and as such they may be in error, nevertheless, they were obtained by a water-settling

Table 8

Time for Particles of Density 2.65 to Settle  
Through 10 cm of Water at Stated Temperature °C

Temperature °C	Particle Size, microns					
	5	10	15	20	30	40
	Settling Time					
10°	1 hr, 16 min	21 min, 30 sec	9 min, 35 sec	5 min, 22 sec	2 min, 29 sec	1 min, 29 sec
15°	1 hr, 6 min	17 min, 30 sec	8 min, 5 sec	4 min, 30 sec	2 min, 12 sec	1 min, 18 sec
20°	57 min, 48 sec	15 min, 18 sec	7 min, 10 sec	4 min, 6 sec	1 min, 54 sec	1 min, 8 sec
25°	51 min, 0 sec	13 min, 36 sec		3 min, 36 sec	1 min, 41 sec	1 min, 0 sec
30°	45 min, 30 sec	12 min, 18 sec		3 min, 14 sec	1 min, 30 sec	53 sec
35°	41 min, 0 sec	10 min, 48 sec		2 min, 54 sec	1 min, 22 sec	49 sec

technique; and since water settling of the particles (from dredging) is a parameter of great interest, the description of this "equivalent" diameter is quite useful.

58. In Table 7 it will be noted that 19 of the 22 samples had mean particle diameters of between 14 and 20 microns. The range of particle-size distributions for these 19 samples is shown in Figure 5. The other three samples, all from channel locations, appeared to be mixtures of mud and sand, such as the particle-size distribution of sample 8 presented in Figure 6.

59. From these data it was concluded that most of the dredge sediment from the Mare Island Strait and most of the sediment from shoaling areas would consist of small particles with a mean particle diameter of about 15 microns and with more than 80 percent of the total mass consisting of particles between 10 and 30 microns in diameter. This then characterized the particle-size distribution of the sediments which would be tagged.

#### Chemical Properties of the Sediments

60. The now disestablished Naval Radiological Defense Laboratory (NRDL) conducted studies with Bay sediments in 1956. NRDL was assisted in the preparation and analysis of the sediments by the San Francisco District Sausalito Laboratory. A chemical analysis conducted by the Corps at that time is reported in Table 9. It was immediately apparent that high temperatures could not be used in tagging Bay sediment since both the chemical and physical properties of the particle would be altered. This indicates that a surface adsorption mechanism had to be used to tag the sediment particles. Table 9 shows that material less than 44 microns in diameter (some 90 percent) is largely silt and clay. The crystal lattice of clay is known to be able to tightly bond or "fix" cations.<sup>7</sup>

61. Since soluble salts in the sediments provide cations to compete with the tagging element, an analysis was conducted on each of the 22 samples to measure salinity, as noted in the following paragraphs.

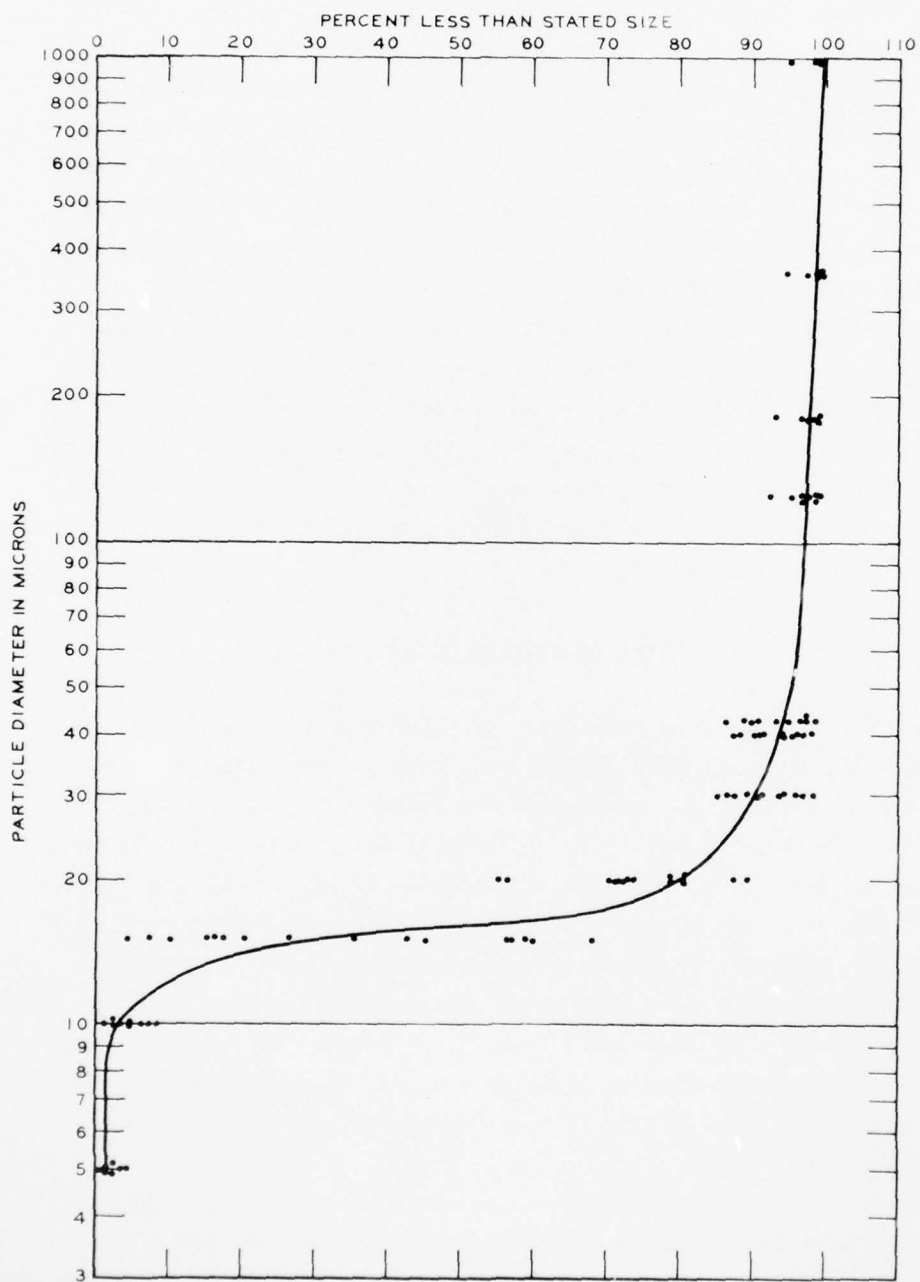


Figure 5. Graph of nondispersed particle mass below stated size for all samples showing single-population distribution

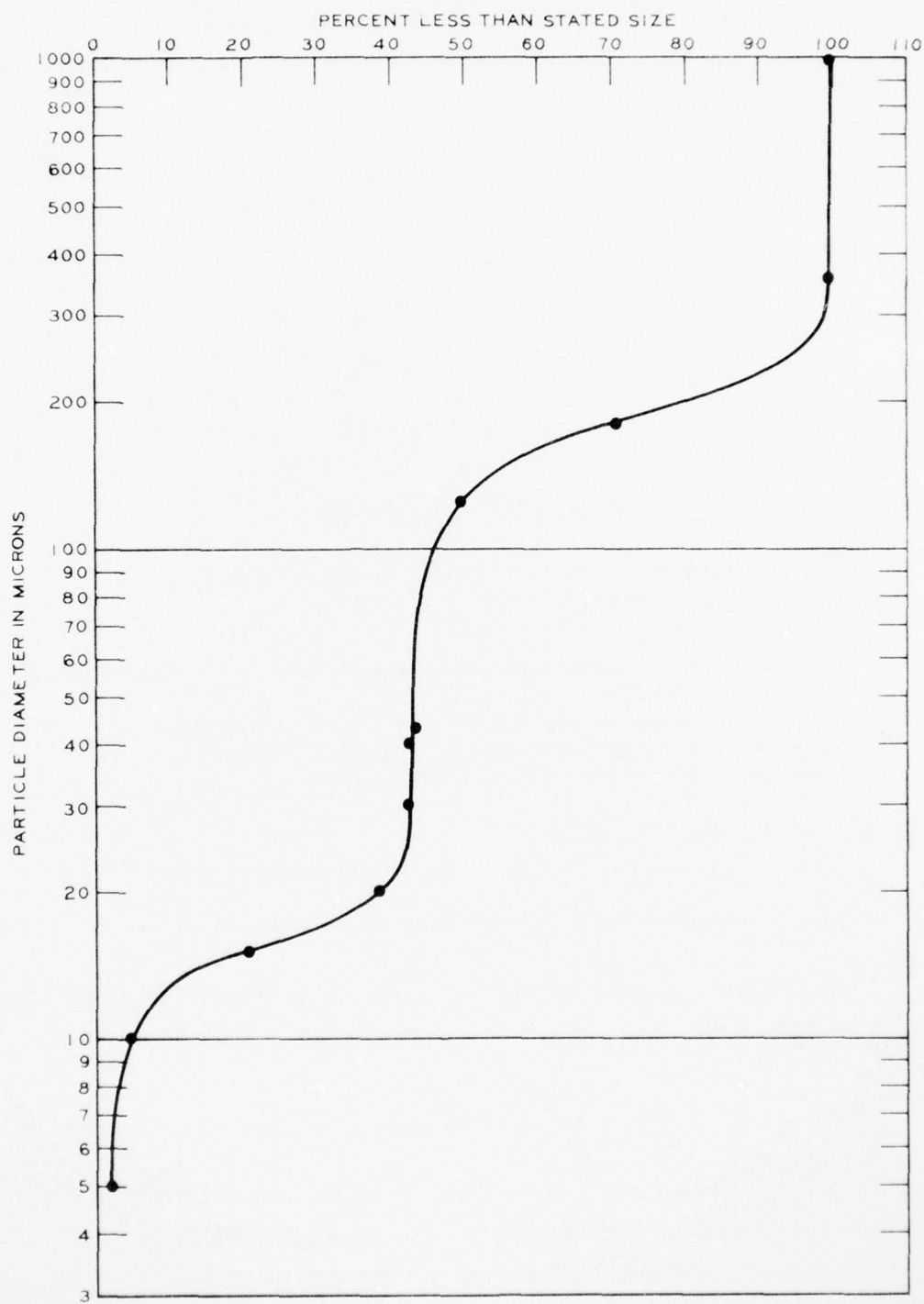


Figure 6. Particle-size distribution of sample 8 from Carquinez Strait

Table 9  
Analysis of Sediments from Mare Island Strait

<u>Oxide Analysis</u>	<u>Percent</u>
Loss of Ignition	8.06
Silica (SiO <sub>2</sub> )	57.74
Aluminum Oxide (Al <sub>2</sub> O <sub>3</sub> )	15.18
Ferric Oxide (Fe <sub>2</sub> O <sub>3</sub> )	6.19
Calcium Oxide (CaO)	2.94
Magnesium Oxide (MgO)	1.68
Sulfur Trioxide (SO <sub>3</sub> )	2.56
Sodium Oxide (Na <sub>2</sub> O)	2.88
Potassium Oxide (K <sub>2</sub> O)	0.86

Material retained on 325-mesh sieve (44 microns):

Organic

Shell fragments - white and blue shell material  
Vegetative - seaweed, wood fragments

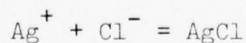
Mineral

Quartz - fine, rounded-to-angular particles of transparent quartz  
Feldspar - angular particles of weathered feldspar  
Mica - thin, fragile plates of yellow and brown  
Iron Oxides - black particles of magnetite

Material passing 325-mesh sieve:

Largely silt and clay. (Clay probably includes montmorillonite.)

62. Quantitative testing for chloride may be accomplished by precipitation with AgNO<sub>3</sub> since AgCl is nearly insoluble in cold water.



63. Small errors may result from chloride ions originating from species other than NaCl and also from other insoluble silver salts. For our purposes, however, this method yields useful measurements of salt concentration differences in Bay sediments.

64. Aliquots of sediments were taken from each of the 22 samples and dried for two days. The percent solids for each sample is listed in Table 7. Ten grams of dried sediments were weighed into clean dry beakers. Approximately 100 ml of distilled water were added and the slurry was brought to a boil. The water was cooled and the sediment particles settled. The water was decanted off and filtered. Another 50-75 ml of distilled water were added to each beaker and then boiled, cooled, decanted, and filtered. Finally, the sediment samples and beakers were rinsed with distilled water and filtered.

65. The filtrates were combined and adjusted to volume in a 250-ml volumetric flask. A 25-ml aliquot of this solution was then filtered through a millipore filter to determine the weight of sediment particles in 25 ml. Another 25-ml aliquot was transferred to a clean beaker. To this, 10 ml of 0.25 N  $\text{AgNO}_3$  were added to precipitate the chloride ions. This solution and precipitate were stirred, allowed to settle, and then filtered through a millipore filter.

66. The millipore filters were oven-dried for half an hour and allowed to cool. After weighing, the weight of the sediment particles in 25 ml is subtracted from the weight of  $\text{AgCl}$ . The percentage of  $\text{NaCl}$  for each of the 22 samples is listed in Table 7. These values, especially the three high ones, indicated the sediment should be washed to dilute the soluble salts prior to tagging. The pH values in Table 7 show no significant difference among the 22 samples.

#### Preparation of Soluble Iridium Tagging Solution

67. Iridium was available only in the form of iridium metal powder. Direct purchase of soluble iridium salts involved considerable conversion costs and delivery delays. Therefore, the 10 kg (22.05 lb) of purchased iridium metal were converted to  $\text{Na}_2\text{IrCl}_6$  in a batch process.

68. Two hundred and fifty grams of powdered metal were thoroughly mixed with 250 g of crystalline  $\text{NaCl}$  and placed in the center section of a quartz tube which was 1.22 m (4 ft) long and 50.8 mm (2 in.) in diameter. The quartz tube was inserted in a tube furnace at 755.4 K

(900°F), with all the iridium mix in the heated section and with 0.3 m (1 ft) of tube protruding from each end. Chlorine gas from a high-pressure cylinder was bubbled through a water bulb and delivered to the front end of the quartz tube. After passing over and through the iridium charge, the unreacted  $\text{Cl}_2$  was discharged from the downstream end of the quartz tube. The tube was rotated through 3.141 radians ( $180^\circ$ ) several times during the chlorination to fluff the charge and insure exposure to the  $\text{Cl}_2$ .

69. The reaction was essentially complete after 24 hr, and the quartz tube and contents were removed from the furnace and cooled. The iridium charge was then released into a  $1.89 \times 10^{-2} \text{ m}^3$  (5-gal) polyethylene container. When five batches (1250 g) of iridium had accumulated, distilled water was added to make  $1.89 \times 10^{-2} \text{ m}^3$  (5 gal) of solution. The solution was agitated several times a day for one week and then filtered into a second container. The filter was dried and ignited to recover the unreacted metallic iridium. The recovered iridium was weighed and recycled to the chlorination process. The weight of the recovered iridium was subtracted from 1250 g to get the concentration of iridium in the freshly prepared solution. A total of 9900 g of iridium was placed in solution. The solution was stored for use during the tagging operation.

#### Fixing Iridium to Dredge Sediments

70. Numerous preliminary tests showed that iridium was strongly bonded to the dredge sediments although the exact mechanism is obscure. No doubt the following factors are involved. The dredge sediments have a cation exchange capacity of about 30 milliequivalents per 100 g, which is much more than adequate for the small concentration of iridium involved (0.1 percent by weight). The small sizes and platy shapes of the particles give very large surface areas for adsorption. According to Coulomb's Law, large attractive forces exist between the negative oxygen ions in the crystal lattice and the adsorbed cation, which is iridium in this case. Other mechanisms such as organic complexes or

chelates no doubt contribute to fixation of iridium to the dredge sediments. To measure the stability of the iridium-tagged sediments over a long period of time and leaching by saline water, the following tests were conducted.

71. Iridium "fixing" tests were conducted using sediments from Mare Island Strait (sample 22, Table 7). One litre of wet sediments was placed in a beaker, and 1 litre of distilled water was added with vigorous stirring. The slurry was allowed to settle for 2 hr, and the water was removed by decanting. This washing was repeated three times to dilute soluble salts and reduce the number of very small particles.

72. Leaching tests were conducted as follows:

A volume of washed sediments containing 4 g of solids was placed in each of three centrifuge tubes. One millilitre of a solution containing 4 mg of iridium was added to each tube followed by an aliquot of solution containing about 20,000 counts per minute (c/m) of Ir-192. This then simulated the iridium concentration which was planned for the tagged sediments. The contents of the tubes were stirred and then mechanically agitated to insure mixing. One tube was placed in a drying oven at 393.2 K (120°C), the second tube was allowed to air-dry, and 20 ml of tap water were added to the third tube. When the first two tubes were thoroughly dry (6 days later), 25 ml of tap water were added to each.

The leaching solutions were thoroughly mixed with the tagged sediments and set aside for several days. Periodically, the leaching solutions were removed from all three tests by decanting into clean test tubes and replaced by equal volumes of fresh tap water. The tube containing oven-dry sediment was leached twice with tap water, and the third and subsequent leaches were water from Mare Island Strait. Table 10 shows the dates and leaching times that apply to the three tests.

On 17 September 1973, 1-ml aliquots were carefully removed from each of the test tubes containing leach solutions and from the three tubes containing tagged sediments and the 5th leach. The 5th leach solution was then decanted into a clean tube, and the 6th leach solution was added. The tagged sediments and the 1-ml aliquots were then counted, and the data are presented in Table 11. It can be seen that when the leach aliquots' activity has been corrected by subtracting background, no significant Ir-192 was removed from the tagged sediments by leaching. The 6th leach was similarly measured on 25 September 1974, and again no Ir-192 was found

Table 10  
Schedule of Leaching Tagged Sediments

<u>Date</u>	<u>Procedure</u>	<u>Leach Interval <math>\Delta t</math> (days)</u>	<u>Leach Time Total <math>\Sigma t</math> (days)</u>
15 Jun 73	Prepared sediments		
20 Jun 73	Dried sediments		
21 Jun 73	Added 25 ml water		
19 Jul 73	Removed 1st leach	28	28
30 Jul 73	Removed 2nd leach	11	39
6 Aug 73	Removed 3rd leach	7	46
4 Sep 73	Removed 4th leach	29	75
17 Sep 73	Removed 5th leach	13	88
25 Sep 74	Removed 6th leach	373	461

in the aliquot although by this time the tagged sediments' activity had decayed to less than 800 c/m.

73. Thus, the leaching data show that iridium is "fixed" to dredge sediments by application to the wet sediments, and that no advantage is inherent in drying or heating the tagged sediments.

Preparation and Assay of a Batch of Tagged Sediments

74. Prior to tagging the sediment material to be added during the dredging operation, a batch of sediments was tagged using essentially the same procedures and equipment to be employed in the large-scale tagging operation. The objective was to proof-test the preparation and analytical procedures.

75. A 0.5-g sample of iridium-tagged sediments ( $10^{-3}$  g Ir/g sediments) was neutron-activated in the TRIGA reactor for 1 hr. Since a concentration of  $10^{-8}$  g Ir/g sediments was anticipated for the released dredge material, a dilution of  $10^5$  was required. Accordingly,

Table 11  
Iridium "Fixing" to Dredge Sediments

	Leach Test 1* c/m	Leach Test 2** c/m	Leach Test 3† c/m
Bkg††	306	305	305
Sediments	12,189	9,277	8,343
1st	328	307	322
2nd	311	308	310
3rd	299	312	319
4th	305	315	313
5th	318	314	315
Bkg	311	306	312

\* Iridium-tagged wet sediments - 4-g sediments, 20-ml tap water.

\*\* Iridium-tagged air-dry sediments - 4-g sediments, 20-ml tap water.

† Iridium-tagged oven-dry sediments - 4-g sediments, 20-ml tap water for leaches 1 and 2, then Mare Island Strait water for leaches 3, 4, 5, and 6.

†† Bkg is normal response of counter with no sample present.

0.155 m<sup>3</sup> (41 gal) of processed sediments from the Mare Island Strait were prepared in a plaster mixer at a density of 1.16 g/cm<sup>3</sup>. The neutron-activated sediments were added to 0.155 m<sup>3</sup> (41 gal) and then mixed for 15 min to insure uniform blending.

76. Three samples of the simulated tagged dredged material were taken from the plaster mixer, dried, and 50 g of each sample were fire assayed. The gamma spectra of the resulting lead were very uniform, and the Ir-192 peak from a 300-sec count was sufficiently large to permit a good measurement after an additional 10-fold dilution and a reasonable signal-to-noise response after a 100-fold dilution. The 100-fold dilution (10<sup>-10</sup> g Ir/g sediment) was expected to be contained in the natural sediment material and fire assay chemicals and, as such,

would be a background value to be subtracted from the field samples.

77. After the particles settled in the plaster mixer,  $3.8 \times 10^{-3} \text{ m}^3$  (1 gal) of water was removed from the top; after filtering, it was evaporated to dryness. The residue was collected in a 40-ml test tube and examined in the spectrometer. No Ir-192 was found.

#### Tagging Operation

78. For the tagging operation, a net weight of  $9.1 \times 10^6 \text{ g}$  (20,000 lb) of Mare Island Strait sediment materials was required. The most desirable source of material would have been from the hopper of a dredge, but, since no dredging was possible prior to the conduct of the tracing operation, the material was obtained from a landfill, dredged material disposal site in the northwestern area of the Mare Island Naval Shipyard. The material in this site had been dredged from the Mare Island Strait over a period of years.

79. Prior to accepting this material for tagging, samples were obtained from five test holes (four corners and the center of a 15.2-m (50-ft) square) 1.5 m (5 ft) deep. The sediments from this test area were found to have the same physical and chemical properties as those from the Mare Island Strait (Table 1).

80. A total of  $1.8 \times 10^7 \text{ g}$  (40,000 lb) of wet marine sediments was removed from the disposal site and delivered to the Stanford Research Institute's (SRI) facilities at Camp Parks near Dublin, California. Here the material was converted from large agglomerated masses to particulate material having the same characteristics and size distribution as that determined to be in the dredge's hoppers during the previous dredging of Mare Island Strait. Figures 5 and 7 show the size distribution of the materials from Mare Island Strait and those resulting from the marine sediments.

81. The agglomerated lumps were converted to particulate materials by first breaking the material into 50.1-mm-(2-in.-) diam pieces using a soil shredder. The pieces were then placed into a  $0.21\text{-m}^3$  (55-gal) drum of water which was slowly agitated using an air-driven

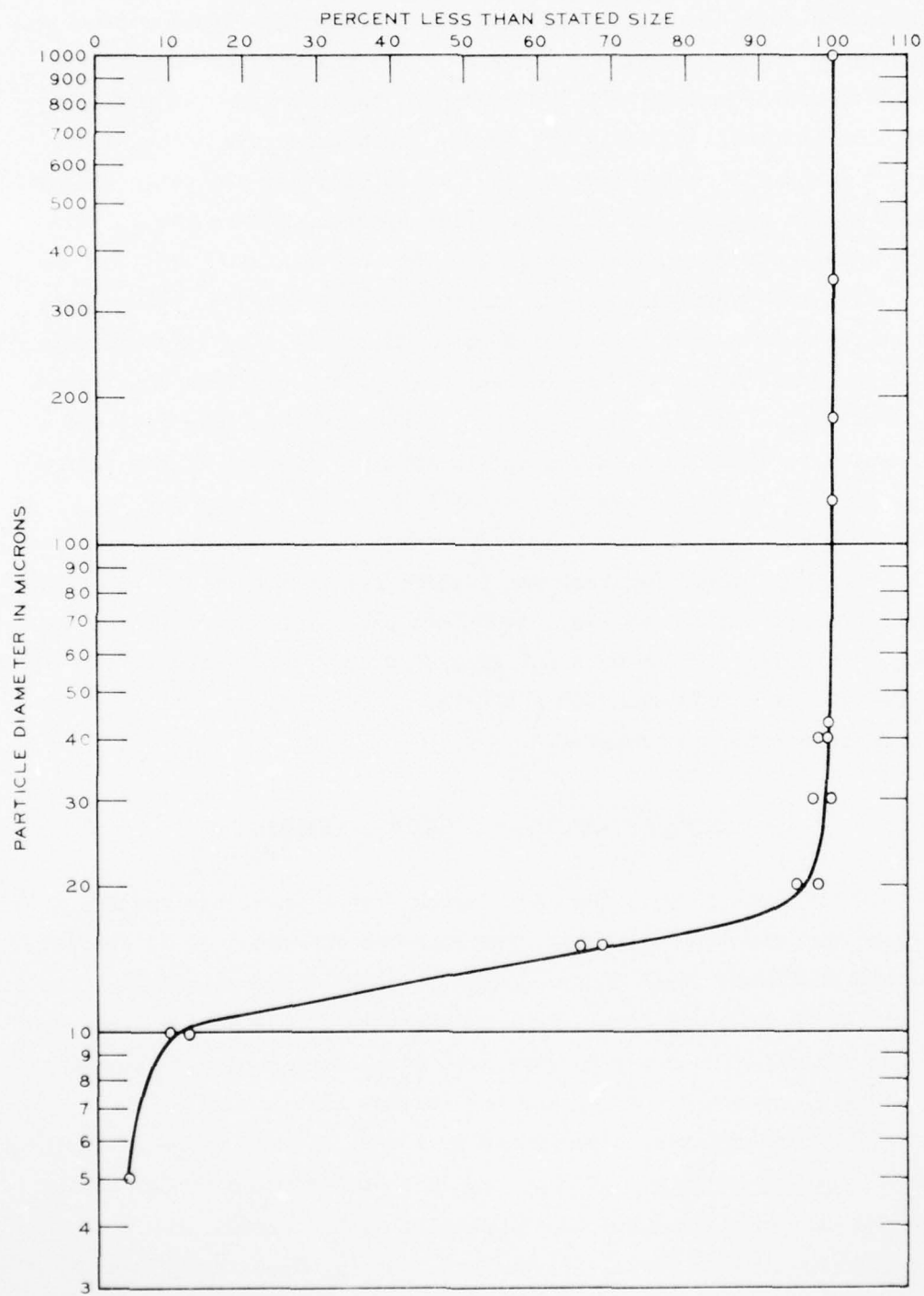


Figure 7. Nondispersed particle-size distribution of sediment material to be tagged

mixer until a slurry was produced. The slurry was transferred to another agitated  $0.21\text{-m}^3$  (55-gal) drum where the solid-liquid content was adjusted to produce a uniform mixture. This mixture was then transferred to storage drums which were sampled to determine the particle-size distribution. While in the drums, fresh water was added, the mixture was agitated and then allowed to settle, and the water was decanted. This process was repeated three times to dilute the soluble salts and remove very fine particles prior to tagging.

82. With sufficient slurry prepared, about  $0.23\text{ m}^3$  (60 gal) of the slurry were pumped into a plaster mixer of the type commonly used by building contractors. After thorough mixing, the slurry's density was adjusted to 1.16 g/ml. The resulting volume was then measured, and a calculated iridium addition was slowly sprayed into the mixing slurry to produce an iridium concentration of 1.212 g of iridium per  $3.8 \times 10^{-3}\text{ m}^3$  (1 gal).

83. The tagged sediment was transferred to  $1.89 \times 10^{-2}\text{-m}^3$  (5-gal) paint cans and  $0.21\text{-m}^3$  (55-gal) drums and palletized for shipment to the dredge. A total of  $30.9\text{ m}^3$  (8169 gal) of slurry containing  $9.86 \times 10^6\text{ g}$  (21,729 lb) of solids and 9900 g (22 lb) of iridium, or  $1.01 \times 10^{-3}\text{ g Ir/g}$  of sediment, was prepared.

#### Dredging and Tracer Addition Operations

84. Figure 8 shows the Mare Island Strait area, the channel area dredged, and the disposal area. Dredging was commenced on 19 February 1974 and continued until 30 March 1974. Dredging operations were conducted for 24 hr a day for 12 consecutive days followed by a 2-day rest period. Thirty-five dredging days were completed, making a total of 706 trips between the channel and the release site.

85. Dredging was accomplished by the U. S. Army Corps of Engineers dredge, Chester Harding. The Harding is a dual-suction dredge having port and starboard variable depth trailing suction arms, each powered by a 1000-horsepower diesel-driven pump. During dredging of the Mare Island Strait, the Harding proceeded ahead slowly with one or both

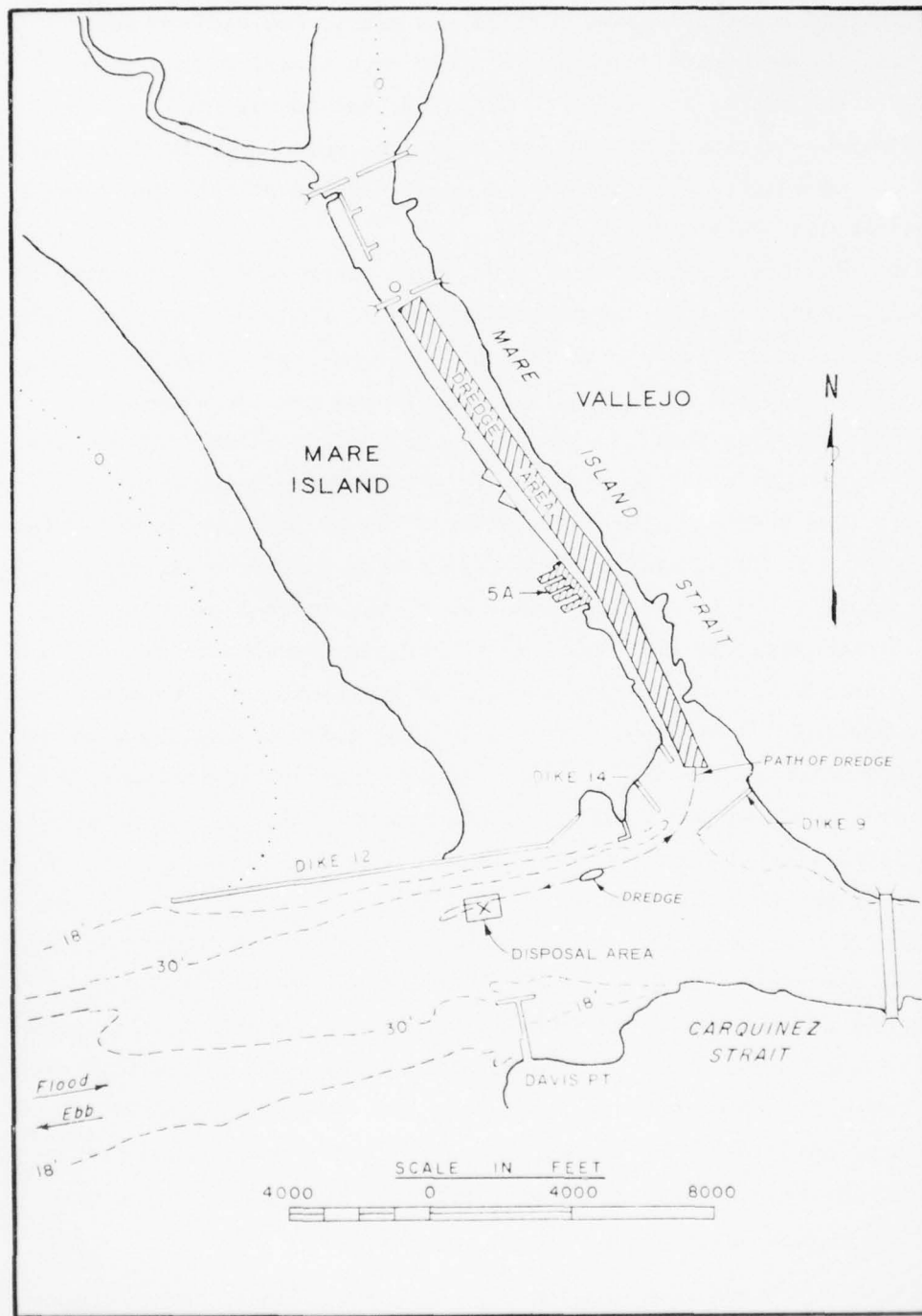


Figure 8. Area dredged in Mare Island Strait

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CORPS OF ENGINEERS SAN FRANCISCO CALIF SAN FRANCISCO--ETC F/6 13/2  
DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)  
AUG 77 J F SUSTAR, R M ECKER, W T HARVEY

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suction arms trailing alongside at a depth that permitted pumping a water-sediment slurry into the dredge's hoppers. The Harding has two bottom-dumping hoppers located forward and aft of the midship superstructure. Dredged materials are fed from both trailing arms into both hoppers. Each hopper is filled to capacity, and to maximize payload, pumping may be continued with excess water and some sediment overflowing back into the channel. Figure 9 is a cross section of a hopper showing its general configuration.

86. San Francisco District personnel\* determined the capacity of the dredge hopper on three separate occasions during the dredging cycle and calculated the volume to be  $1758 \text{ m}^3$  ( $2300 \text{ yd}^3$ ) per trip. For the dredging cycle of 706 loads, the total sediments removed were  $5.12 \times 10^{11} \text{ g}$  (504,000 long tons). With 9900 g of iridium added, the concentration of iridium was  $1.95 \times 10^{-8} \text{ g Ir/g}$  of sediments dredged.

87. The traced sediments were added to the two hoppers via standpipes located in the center of each hopper with their outlets extending approximately 1.8 m (6 ft) below the top of the dredged material (Figure 9). Approximately  $2.27 \times 10^{-2} \text{ m}^3$  (6 gal) of traced sediments were added to each hopper by pouring the traced sediments into the standpipe, sealing the top of the pipe, and pressurizing and flushing the pipe with the ship's water supply (Figure 10). To preclude contamination of the channel by overflow, the addition of the traced sediments was always accomplished after the dredge had departed from the channel and prior to its arrival at the release site.

88. The release site location, shown in Figure 8, is in the Carquinez Strait where the water depth is approximately 18.3 m (60 ft). Once at the release site, the dredge pumps were activated pouring water on top of the loaded hoppers while simultaneously opening the hoppers' dump doors. The above actions produced a very turbulent condition in the dredged material being discharged. This turbulence, plus that encountered in water following hopper discharge, served to further mix the traced sediments with the dredged sediments.

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\* Memo: Mr. John Sustar, SFD, to Mr. E. Leahy, EERL, of 17 May 1974.

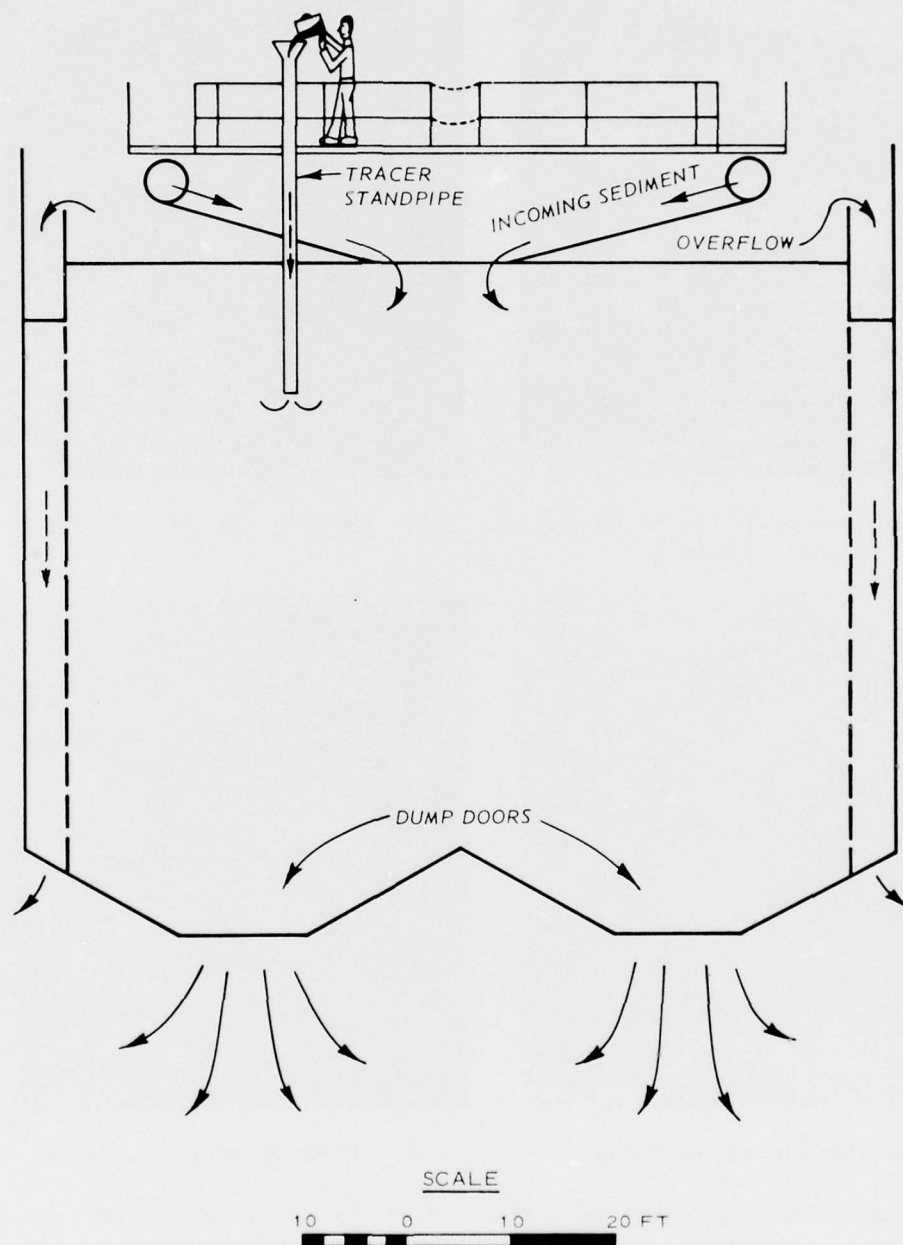
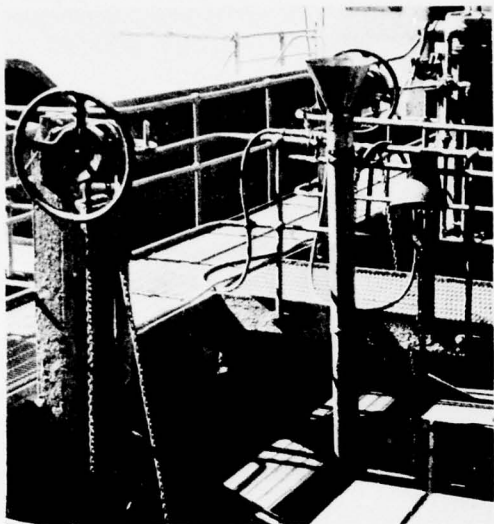
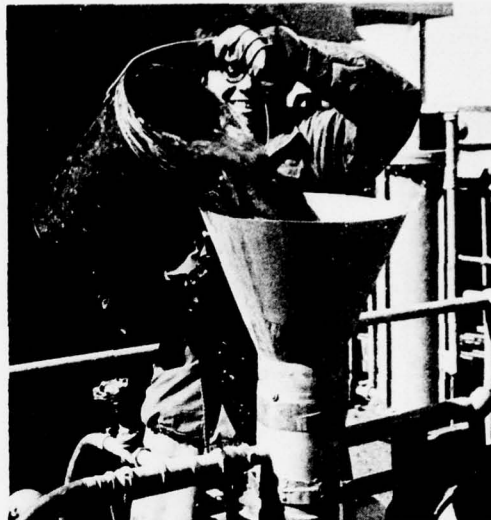


Figure 9. Schematic cross section of Harding's hoppers



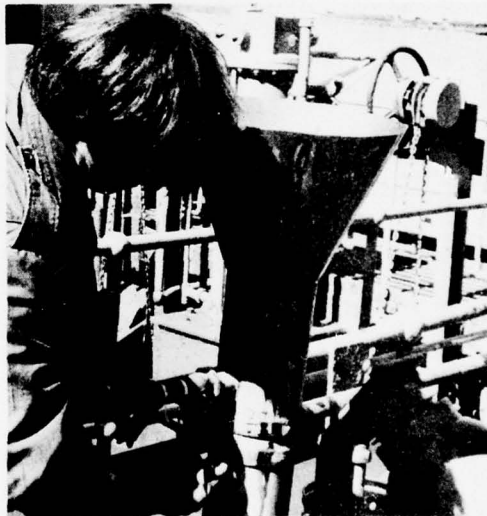
a. Loaded hopper prior to adding traced sediments



b. Adding traced sediments



c. Rinsing funnel and sealing



d. Pressurizing standpipe

Figure 10. Addition of Traced Sediments to Loaded Hopper

#### PART IV: SAMPLING OPERATIONS AND ANALYSIS

##### Test Area and Grid System

89. Figure 2 shows the area sampled for the tracer program. The area included San Pablo and Suisun Bays, and Carquinez Strait which connects the two bays with the Mare Island Strait. Figure 11 shows the tracer program sample grid overlaid on Figure 2. For sample location identification, each sample point was given a numerical designation as shown in the figure. The numerical designators, referred to as hole numbers, were assigned when the sampling boat first reached a location. The order of points sampled in any particular time period depended on the current direction at the time. A total of 111 locations were so designated.

90. To assist in locating the hole numbers in the test area, each hole number was further described by a major and minor grid system. The major grid consisted of squares with 2037.2-m (1.1-nautical mile) sides having a numerical designation in the X direction and a letter designation in the Y direction. Each individual grid was further subdivided into squares with 203.7-m (0.11-nautical mile) sides and a similar numerical-letter designation system. The convention adopted for identifying samples was to list the hole number followed by the major and minor alphabetical designators and then the major and minor numerical designators. For example, in Figure 11, hole number 72, also designated with coordinates H, h-4, 3, is located in the major grid defined by H and 4 and the minor grid by h and 3.

##### Sampling Operations

91. Sampling operations were conducted using a modified World War II type landing-craft medium (LCM). The LCM, which was on loan to the San Francisco District from the National Oceanographic and Atmospheric Administration, was equipped with a navigation bridge containing radar, depth indicator, and conventional small-craft navigational instruments.

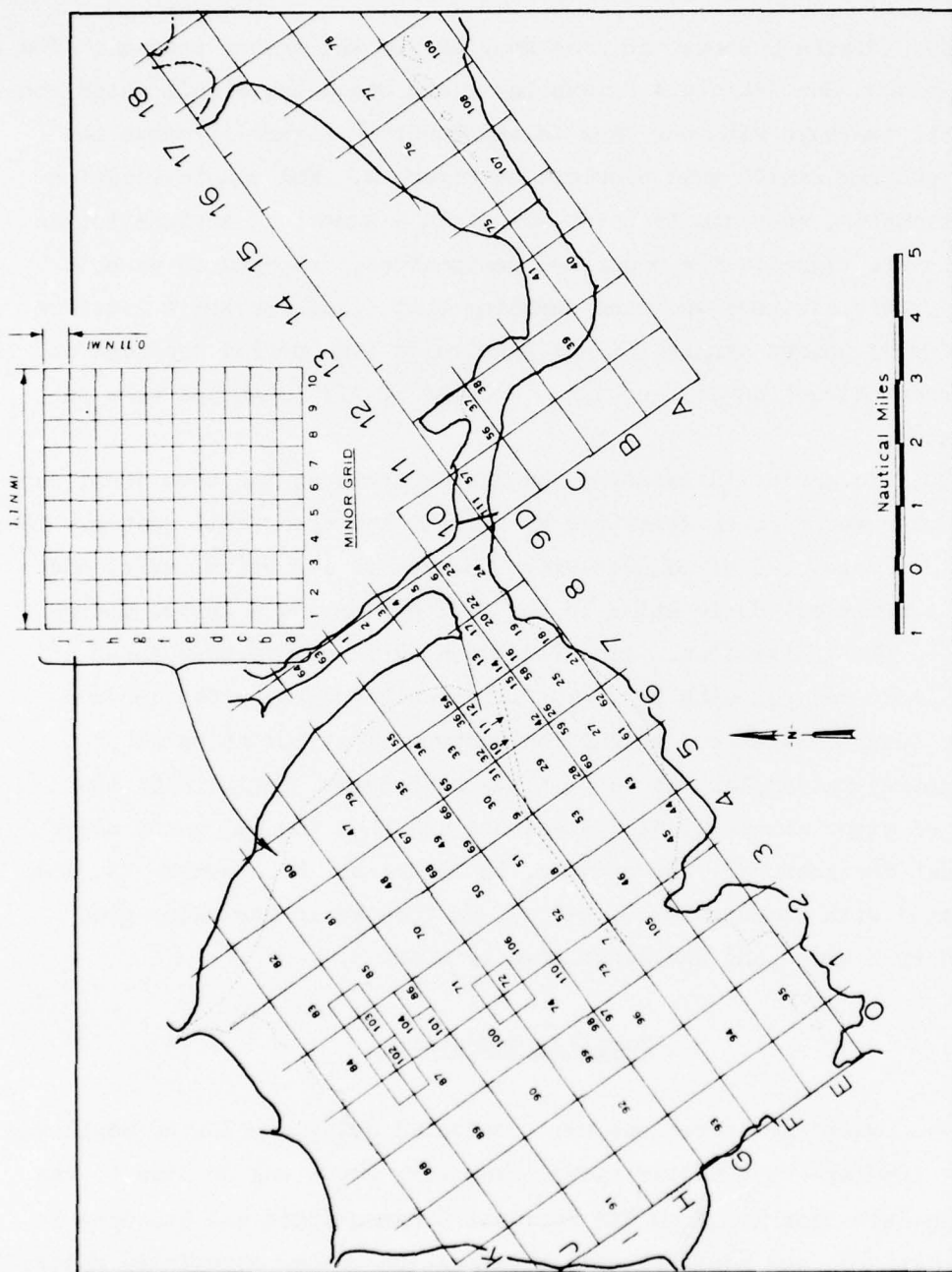


Figure 11. Tracer program grid

92. For sampling operations, the cargo deck of the LCM had been modified to contain a well. A double "A" frame was positioned above the well. The "A" frame and a motor-driven block and tackle were used to handle a wash-bore, push-type, verticle-tube core sampler. The core sampler contains a 762- by 54-mm-ID (30- by 2-1/8-in.-ID) clear acrylic liner and a vacuum seal system to retain the sampled material in the core liner.

93. In a typical sampling operation, the sample boat was brought into position, using sextant and radar navigation, and anchored. At some locations where the water was shallow the sample locations were marked with a stake. The depth of the top of the sediments was referenced to mean lower low water (mllw) and was determined by the depth indicator and the reference to a tide gage reading and the tide tables. Lengths of pipe were fixed to the core sampler head, and the unit was lowered through the well in the cargo deck via the "A" frame and its block and tackle to a depth just above the bottom. The sampler was then pushed into the bottom for a distance of about 762 mm (30 in.). While in place, a sealing ball was inserted into the top of the handling pipe followed by a steel bar to seat the sealing ball. The sampler was retrieved, and the liner containing the cored sediment material was carefully removed, capped on both ends, labeled, and logged. Five cores were taken at each sampling location. Figure 12 shows several groups of



Figure 12. Sediment cores collected from a number of sample locations

five core samples prior to being boxed for shipment.

94. Figure 13 is a typical log sheet completed for each sampling location. The first horizontal line indicates the hole number, major and minor grid coordinates, date, time, gage readings, measured water depth, and wind, wave, and current direction data. The data for each core are listed above the tube sketch showing the tube number, the depth pushed into the sediment, the measured amount of solid material in the tube, and the elevation of the top of the sediment referenced to mllw. Each tube was diagrammed on the log showing the measured depth of various materials in the tube. The nomenclature used is shown in the figure. The designation of "Fluff" was used to describe the very fine mineral particles suspended in the top layer of the sample. "Active" was used to describe the most recently deposited sediments which are believed to be easily resuspended by wave and/or current action. "Inactive" described the sediments that are believed to move rarely, if ever. The distinction among the various layers is made by visual examination of each tube.

#### Sample Processing

##### Core processing

95. The daily collection of samples was removed from the boat and stored ashore. Weekly, the collected samples were transported from storage to the processing area of SRI at Camp Parks located near Dublin, California.

96. SRI personnel took the five tubes from a particular location, carefully removed the top 25.4 mm (1 in.) of material from each tube, and then dried and recorded the weight of solid sediment material. The top 25.4 mm (1 in.) were selected in an effort to obtain sufficient sediment materials from the very fluffy-like sediments that were in the process of transport and settling in a particular location.

97. Once the top 25.4 mm (1 in.) were removed, one of the five tubes was selected and its sediments were carefully removed in 101.6-mm (4-in.) increments. Each increment was dried, weighed, and recorded.



The remainder of the tubes were stored for possible future use.

98. Each dried sample was then ground in a Wiley Mill and passed through a 20-mesh sieve. To prevent cross contamination in the grinding operations, the Wiley Mill and sieve were cleaned after each sample grinding, and the first 50-80 g of the next sample were passed through the mill and discarded. The remainder of the sample was then ground and stored until sufficient samples were prepared for the fire assay process.

#### Fire assay process

99. In the fire assay process, 50 g of the dry ground sediments are mixed with 60 g of litharge ( $\text{PbO}$ ), 20 g of sodium carbonate ( $\text{Na}_2\text{CO}_3$ ), 18 g of sodium borate ( $\text{Na}_2\text{B}_4\text{O}_7$ ), and 2-5 g of starch. The amount of starch used for lead reduction varies with the type of mineral particles and organic material in the sample.

100. After thorough mixing, the material is placed in a refractory crucible and heated to 1338.7 K (1950°F) and held for 1 hr. The molten mass is then poured into a steel mold where the slag forms on top and the lead settles to the bottom. When cool, the slag and lead are separated, and the slag is discarded. The weight of the metallic lead recovered is 30-50 g depending on the  $\text{PbO}$  reduction by the combined action of sediments and starch. The lead mass is weighed, formed into a right cylinder, and sealed in a 12.7-mm-(1/2-in.-) OD  $\times$  63.5-mm-(2-1/2-in.-) long numbered aluminum tube. Each tube is then leak-tested and placed in a 139- by 25.8-mm (5.5- by 1-1/8-in. ) polyethylene irradiation container.

#### Neutron activation

101. All irradiations were performed in the Lazy Susan Facility of the General Atomic TRIGA Mark III Reactor operated by the Nuclear Engineering Department of the University of California, Berkeley. The Lazy Susan is a specimen rack contained within a dry chamber surrounding the reactor core. The specimen rack has 41 sample locations evenly spaced around the circumference. Of the 41 locations, 38 were available for use.

102. With the reactor operating at a 1-megawatt (MW) power level

(thermal), the nominal neutron flux at midline of the specimen chamber is  $5 \times 10^{12} \text{ n}/(\text{cm}^2 \times \text{sec})$ . All irradiations were conducted for 1 hr at a 1-MW power level.

103. The samples remained in the Lazy Susan for at least 48 hr after irradiation to allow decay of the short-lived radionuclides induced in the aluminum and sediment components. For this storage period, the Lazy Susan was placed in an up-position which is essentially out of the thermal neutron flux and permits reactor operation for other purposes.

104. The neutron flux experienced by the samples was determined by placing a flux monitor in every fourth irradiation container. Flux monitors were known amounts of iridium,  $4.12 \times 10^{-5} \text{ g Ir}$ . After approximately 20 days of decay, the flux monitors were measured in the SRI 4-pi ion chamber,<sup>8,9</sup> and the flux was calculated. The flux calculated for a particular location was considered to apply to the irradiation cans adjacent to the can monitored.

#### Sample counting

105. After at least 48 hr of cooling time in the reactor, the samples were removed, packaged in shielded containers, and transported to SRI's Camp Parks Facility. At SRI the samples were stored for approximately 20 days to permit further radioactive decay.

106. When the decay period had passed, the lead slug was removed from the aluminum tubing and placed in a 50.8-mm-(2-in.-) diam aluminum foil weighing dish. The dish and lead slug were heated until the lead melted and formed a smooth disc on the bottom of the dish. After cooling, the sides of the dish were folded in, and the sample was ready for counting.

107. Counting was performed using an ORTEC lithium-drifted germanium diode and preamplifier connected to a Canberra 1024 channel analyzer. The Canberra analyzer was connected to both a teletype printer-paper tape unit and an X-Y plotter. The teletype printer-paper tape unit was used to enter sample identification data and to record output from the Canberra analyzer. The X-Y plotter gave a visual presentation of the sample spectra as shown in Figure 14. The punched

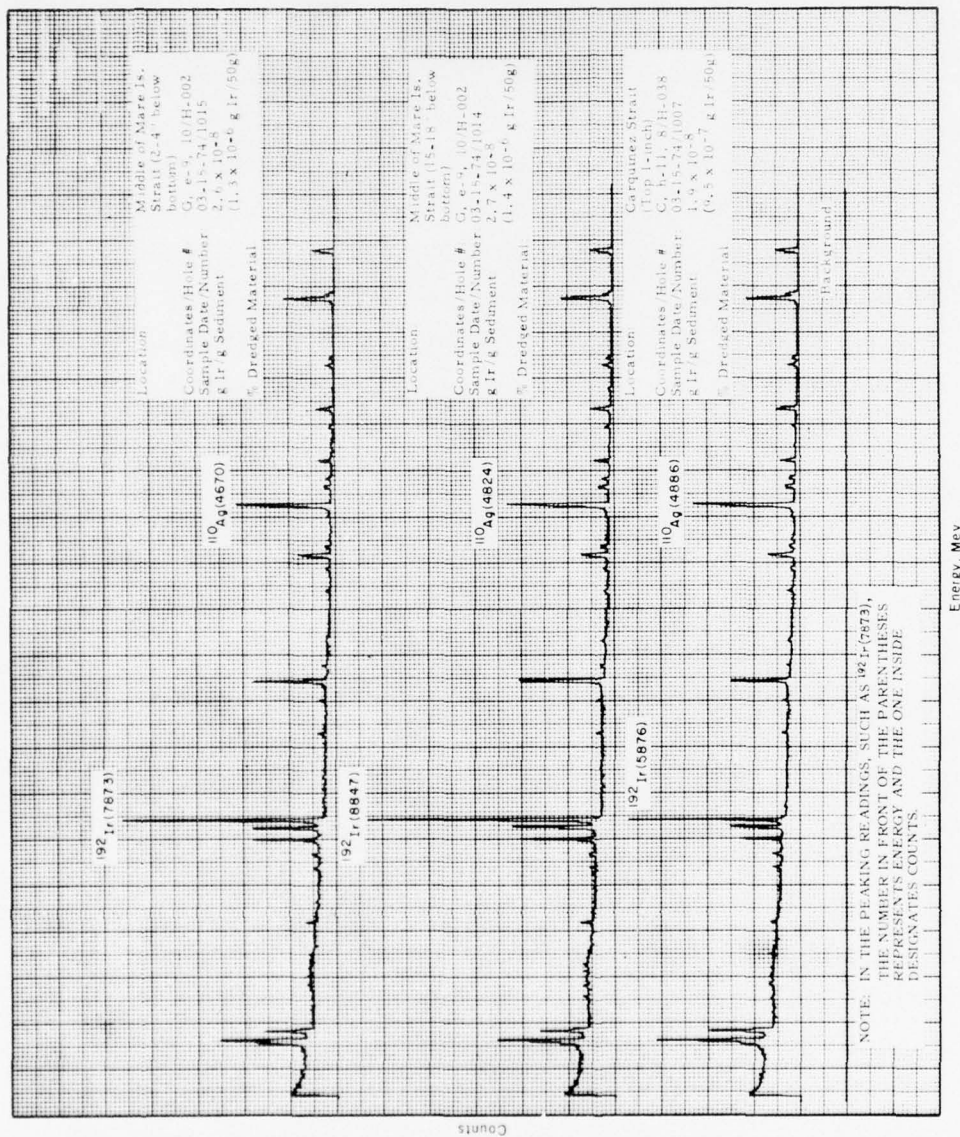


Figure 14. Typical spectra of fire-assayed 50-g sediment sample

paper tape was used to input the sample identification and spectra data into computer codes which calculated the amount of iridium in a sample and the mass of dry sediment per unit volume of wet sample. The percentage of dredged material represented by the iridium was then calculated.

108. The amount of iridium in a sample was calculated by integrating the area under the 316-keV photon peak. Each sample was counted for a total of 300 sec. The following calculations were performed to determine the amount of iridium in a sample.

109. Total counts ( $C_T$ ) in the 316-keV photon peak were determined by considering the counts in channels (ch) 313 and 318 or 319 as being background noise and subtracting this noise value from the total counts

$$\begin{aligned} C_T &= \sum \text{counts (ch 313 to 319)} - [3(\text{ch 313}) + 4(\text{ch 319})] \\ &\text{if ch 319} > \text{ch 318} \\ &= \sum \text{counts (ch 313 to 318)} - [3(\text{ch 313}) + 3(\text{ch 318})] \end{aligned}$$

The  $C_T$  were then corrected for decay to determine counts at the end of irradiation

$$C_{T_o} = \frac{C_T}{e^{-0.693t/T_{1/2}}}$$

where

$C_{T_o}$  = counts at the end of irradiation

$C_T$  = counts at counting time

$t$  = time after irradiation (days)

$T_{1/2}$  = half-life of  $^{192}\text{Ir}$  (74.37 days)

$C_T$  at irradiation time were then converted to dis/sec

$$I_o = \frac{C_{T_o}}{(B)(E)(RG)}$$

where

$I_o$  = dis/sec at end of irradiation

$B$  = counting time (300 sec)

E = counting efficiency, 0.0234 counts per disintegration

RG = fire assay recovery and counting geometry factor, 0.514

110. Counting efficiency was determined by measuring a radioactive iridium solution in the SRI 4-pi ion chamber and then taking aliquots of that solution, drying the solution to a point source, and determining the count rate observed in the 316-keV photon peak as previously described. Point-source counting efficiency (E) was

$$E = \frac{\frac{C}{S_{316}}}{A_o}$$

where

$C/S_{316}$  = counts per sec measured under the 316-keV photon peak

$A_o$  = activity of the point source (dis/sec)

The recovery-geometry factor (RG) was determined by measuring the activity of radioactive iridium solutions in the SRI 4-pi ion chamber and then tagging San Francisco Bay mineral particles with various concentrations of the solution. The tagged minerals were fire-assayed using the same procedures as previously described and the recovered lead was melted into a disc and counted. The RG was expressed as

$$RG = \frac{\frac{C}{S_{316}}}{A_o \times E}$$

The weight of iridium ( $W_{Ir}$ ) in a sample was written as

$$W_{Ir} = \frac{I_o A}{\sigma N_c m \phi \left( 1 - e^{-0.693 t_i / T_{1/2}} \right)}$$

where

$W_{Ir}$  = weight of iridium (g)

$I_o$  = activity of sample at  $T_o$  (dis/sec)

A = atomic weight of  $I_r$ , 192.2 g

$\sigma$  = neutron cross section of  $^{191}Ir$  (n, $\gamma$ )  $^{192}Ir$  reaction,  
 $7.50 \times 10^{-22} \text{ cm}^2$

$N_c$  = Avagadro number,  $6.02 \times 10^{23}$  molecules/mole

$m$  = percentage of isotopic abundance (37.3%)

$\phi$  = neutron flux ( $n/(cm^2/sec)$ )

$t_i$  = length of irradiation (1 hr)

$T_{1/2}$  = half-life of  $^{192}Ir$  (hr)

With the weight of iridium in a sample known, the grams of iridium per gram of dry sediments and the percentage of dredged material in a sample were calculated as follows:

$$SIr = \frac{(W_{Ir})(Pb_y)}{(Sw)(Pb_a)}$$

where

$SIr$  = grams of iridium per gram of dry sediments (g Ir/g)

$Pb_y$  = weight of lead from fire assay process (g)

$Sw$  = weight of sediments fire-assayed (g)

$Pb_a$  = weight of lead irradiated

$$\text{Percentage of dredged material} = \frac{SIr - Bkg}{D_c} \times 100$$

where

$Bkg$  = naturally occurring iridium in San Francisco Bay sediments plus iridium in fire assay chemicals =  $3.16 \times 10^{-10}$  g Ir/g

$D_c$  = concentration of iridium in dredged materials, 9900 g on  $5.12 \times 10^{11}$  g of sediments dredged =  $1.95 \times 10^{-8}$  g Ir/g

Background for the San Francisco Bay mineral particles was determined by the previously described irradiations conducted at University of California and noted in Table 2, by irradiation and chemical separations techniques conducted by the Lawrence Livermore Laboratory, and from a large number of fire-assayed samples of sediments collected during the sampling of San Francisco Bay.

111. The Lawrence Livermore Laboratory determined\* a limiting value only for iridium using radiochemistry techniques. The limit

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\* Memo: Mr. Austin Prindle (LLL) to Mr. E. Leahy, EERL, of 1 March 1974.

determined was  $\geq 1 \times 10^{-10}$  g Ir/g of sediment.

112. To define the iridium background for the sediments and for the fire assay chemicals, a total of 366 fire-assayed samples were averaged and accepted as representing the background of iridium in the Bay. The samples were those showing "no iridium" from the early post-dredging collection periods. The arithmetic average was determined to be  $3.16 \times 10^{-10}$  g Ir/g of sediment with a standard deviation of  $1.49 \times 10^{-10}$ . This value was considered as the best representation of the iridium background of the sediments including the iridium contributed by the fire assay chemicals.

113. Using  $3.16 \times 10^{-10}$  g Ir/g of sediment as background, in a 50-g fire assay sample, the total iridium from background and chemicals is  $1.58 \times 10^{-8}$  g Ir per counting sample. The level of tracer on the dredged sediments is  $1.95 \times 10^{-8}$  g Ir/g of dredged materials. Thus, in a sample with 1 g of dredged material and 49 g of natural sediments, the total signal is  $3.49 \times 10^{-8}$  g Ir per sample. This amount of iridium is easily detectable and permits detection of dredged material concentrations of 2 percent and less in a sample.

114. Figure 15 shows a typical printout from the calculational codes for one sample hole. The data for the 111 holes are presented in Part I of Appendix A, which is published under separate cover. In the figure, the first two lines give the coordinates of the sample, the hole designation, and the name of the general area in which the sample is located. The third line lists the date the sample was collected. The next four lines show the distance to the top of the sediment below mllw in feet and the thickness in inches of the fluff, active, and inactive layers as recorded on the sample log sheets at sample collection time.

115. The remainder of the data lines pertain to a particular sample and repeat for each sample. Sample A represents the first 25.4 mm (1 in.) of material taken from all five cores and combined into one sample. The number opposite sample A is the capsule number assigned by SRI personnel and used throughout the processing steps. The numerical values are not in order since they are assigned when a sediment sample

COORDINATES		HOLE	LOCATION										
G A 3 10		NO.	7	SAN PABLO STRAIT									
SAMPLING DATES		11MAR74	20MAR74	24APR74	15MAY74	19JUN74	22JUL74	20AUG74	28SEP74	7OCT74	15NOV74	40EC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		42.0	41.0	41.0	39.0	40.5	40.0	40.0	40.0	40.0	41.0	40.0	
THICKNESS OF LAYERS (IN)		1.5	0.2	1.5	1.5	0.0	0.5	0.0	0.0	6.0	1.0	0.0	
FLOFF		15.0	4.5	12.0	11.0	13.0	5.0	4.0	7.0	12.0	5.0	3.0	
ACTIVE		3.0	14.0	11.0	15.0	14.0	14.0	9.0	20.0	11.0	21.0	22.0	
INACTIVE													
SAMPLE A		1001	3787	1234	1492	1846	2005	2428	2725	2845	3352	3481	
G.DRY/CC.WET MUD		0.703	0.450	0.517	0.514	1.307	0.840	0.708	1.095	0.846	0.684	0.746	
G.IR/G.DRY MUD		2.00E-08	5.87E-11	8.14E-10	2.98E-10	2.05E-10	5.80E-10	3.18E-10	3.64E-10	4.01E-11	2.11E-10	1.09E-10	
DREDGE MATERIAL		101.150	0.000	2.555	0.000	0.000	1.354	0.016	0.246	0.000	0.000	0.000	
SAMPLE B		1002	3788	1235	1493	1847	2006	2429	2726	2846	3353	3482	
G.DRY/CC.WET MUD		1.148	0.924	1.358	0.514	1.520	0.900	0.575	1.014	1.041	0.562	0.372	
G.IR/G.DRY MUD		1.26E-08	-BOL-	1.01E-09	3.85E-10	3.30E-10	1.79E-10	1.87E-10	2.56E-10	-BOL-	-BOL-	3.29E-10	
DREDGE MATERIAL		63.036	0.000	3.585	0.355	0.070	0.000	0.000	0.000	0.000	0.000	0.066	
SAMPLE C		1003	3789	1236	1494	1848	2007	2430	2727	2847	3354	3483	
G.DRY/CC.WET MUD		1.004	0.660	0.982	0.567	1.433	0.860	0.774	0.740	1.098	0.682	0.475	
G.IR/G.DRY MUD		3.43E-09	-BOL-	1.92E-09	4.36E-10	3.47E-10	4.41E-10	4.33E-11	3.75E-11	4.01E-10	1.95E-10	4.85E-10	
DREDGE MATERIAL		15.988	0.000	8.229	0.613	0.158	0.641	0.000	0.304	0.436	0.000	0.866	
SAMPLE D		4891		4151	4153				4155	4157			
G.DRY/CC.WET MUD		0.789		0.552	0.564				0.626	0.763			
G.IR/G.DRY MUD		5.61E-10		3.45E-10	2.34E-10				3.70E-10	3.34E-10			
DREDGE MATERIAL		1.258		0.146	0.000				0.279	0.091			
SAMPLE E		1005											
G.DRY/CC.WET MUD		1.230											
G.IR/G.DRY MUD		2.23E-08											
DREDGE MATERIAL		112.616											
SAMPLE F		1006		4152	4154						4158		
G.DRY/CC.WET MUD		0.921		0.723	0.671						1.251		
G.IR/G.DRY MUD		6.97E-09		2.30E-10	-BOL-						4.48E-10		
DREDGE MATERIAL		34.133		0.000	0.000						0.678		
SAMPLE G		4892											
G.DRY/CC.WET MUD		0.777											
G.IR/G.DRY MUD		-BOL-											
DREDGE MATERIAL		0.000											
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
DREDGE MATERIAL													

Figure 15. Sample data output

is processed. The density of the layer is listed in terms of grams of dry material per cubic centimetre of wet mud. The amount of Ir/g of dry material is determined from the fire assay of 50 g of dry sediments. The percentage of dredged material is determined as previously presented. Additional samples taken from a single core at a location are labeled B, C, D, etc. Each alphabetic designator consists of 101.6 mm (4 in.) of material. Thus, B represents the material residing between 25.4 and 127 mm (1 and 5 in.) below the surface; C, between 127 to 228.6 mm (5 to 9 in.) below the surface.

#### Special Samples

116. In addition to the samples collected in the test areas, samples of sediments were also collected: (a) from the hoppers of the dredge during the February-March 1974 dredging; (b) from selected shoaling areas of the Central and South Bays between the cities of Richmond and San Mateo (Figures 1 and 16); and (c) from 10 cross-section profiles of the Mare Island Strait (Figure 17). The data collected from these samples are discussed in Part V; the reason for their collection is given below.

##### Hopper samples

117. Samples of the materials being dredged from Mare Island Strait in February-March 1974 were collected from the hoppers of the Harding on every tenth dredging pass. The purpose of the samples was to attempt to determine if the dredge was rehandling previously dredged material. The dredged material was collected by dipping a new plastic container directly into the sediments in the hopper and immediately resealing the container. A complete set of results of this sampling effort is presented in Part II of Appendix A.

##### Central and South Bay samples (outside test area)

118. Samples of the shoaling materials were collected, using the same coring technique as in the test area, at 20 locations in the Central and South Bays during September-December 1974. The purpose

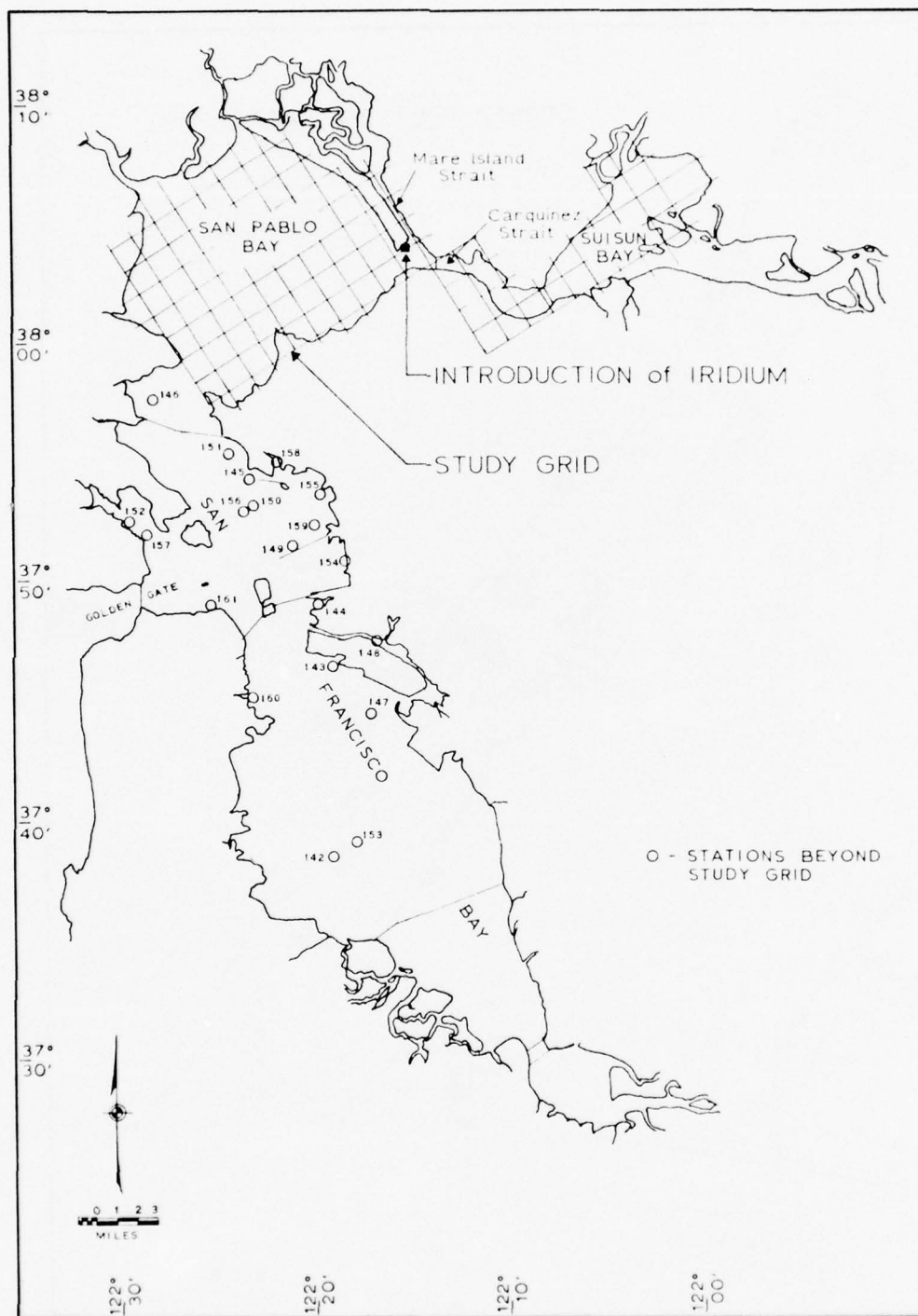


Figure 16. Tracer program location map of stations sampled in Bay areas beyond study grid

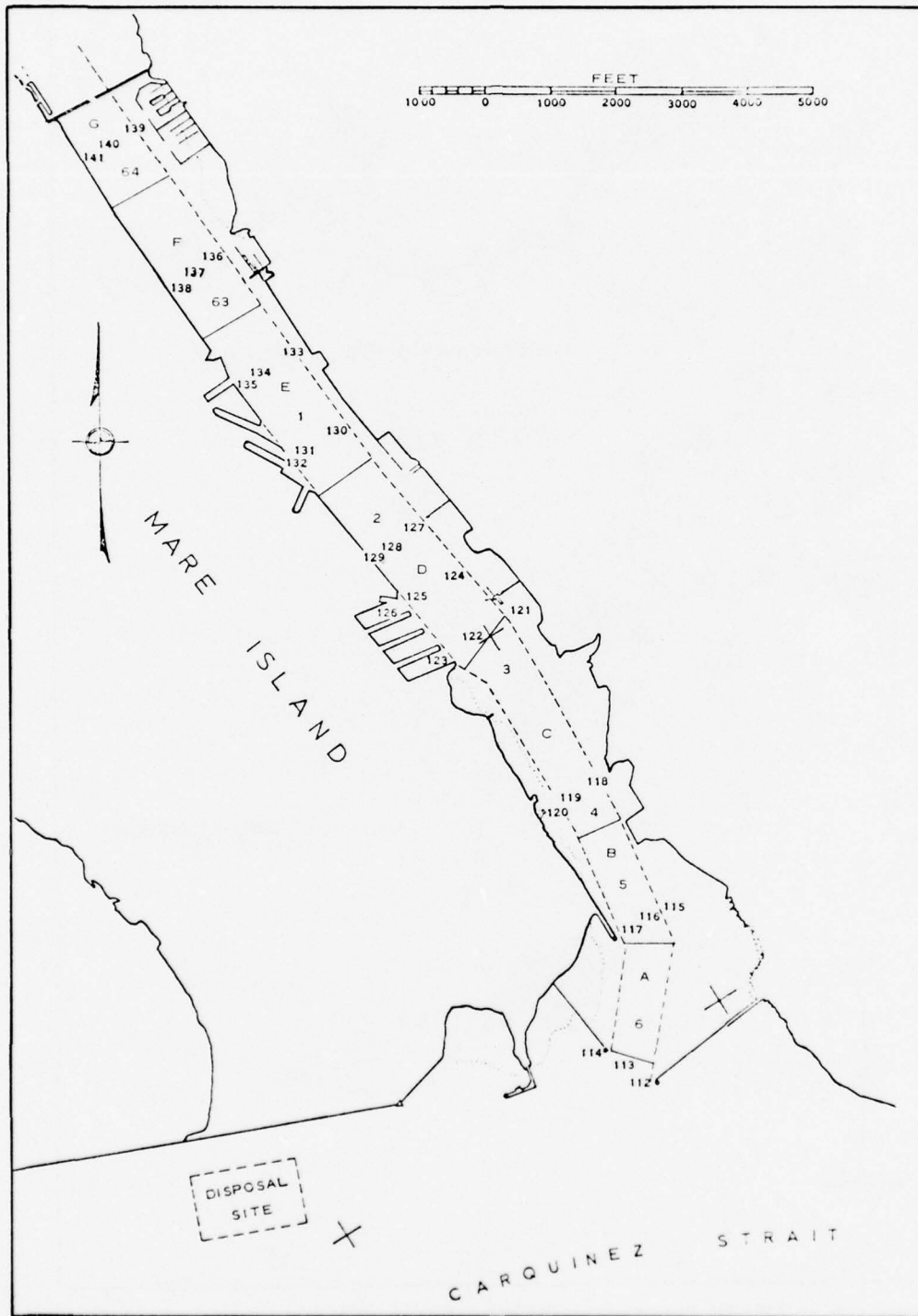


Figure 17. Mare Island Strait cross-section stations and channel sections

of these samples was to determine if dredged material from Mare Island Strait which was released in Carquinez Strait was a significant contributor to the shoaling in the selected areas. These samples were processed in the same manner as the other Bay samples. The complete set of results of these samplings is given in Part III of Appendix A.

Mare Island Strait  
cross-section profiles

119. In September 1974, dredging was again scheduled to remove the accumulated sediments in the Mare Island Strait. Prior to this dredging, in late August 1974, 30 cores were collected at 10 cross-section profiles of the Mare Island Strait. These samples were split into two equal sections per sample tube. Each section was homogenized, and an aliquot of 50 g of dry sediment was taken for analysis. The complete set of results of this analysis is presented in Part IV of Appendix A.

## PART V: RESULTS AND CONCLUSIONS

### General

120. The detailed analysis and interpretation of sample data in terms of sediment transport and shoaling will be performed by the San Francisco District. This report presents only sufficient data to demonstrate the effectiveness of the tracer for labeling and following the movement of dredged material. In the San Francisco District's report,<sup>10</sup> the results of the tracer program will be combined with data from other programs to produce an in-depth analysis of the sediment transport and shoaling process. This report will also contain a complete listing of all data collected during the March-December 1974 sampling of San Francisco Bay. The same listing is also included in Appendix A.

### Samples

121. During the March-December 1974 period, the following samples were collected:

- a. A total of 56 samples from the dredge's hoppers just after loading and prior to starting toward the disposal site. (Since the Harding made 706 round trips, a sample represents an average of 12 trips.)
- b. Approximately 110 samples each month for 10 months from the test area grid (Figure 11).
- c. A total of 30 profile samples from the Mare Island Strait in August 1974 just prior to redredging the channel in September and October 1974 (Figure 17).
- d. A total of 20 samples from areas of the Bay outside the test area (Figure 16).

122. From the above field sampling operations, a total of 3990 laboratory samples and several hundred control and background samples were processed and analyzed for iridium. Portions of the results from each of the above sampling operations are presented to demonstrate the tracing capability achieved.

#### Hopper samples

123. Table 12 lists the date, time, approximate dredging location, and percentage of dredged material in the dredge's hoppers during the February-March dredging operation. The dredging locations refer to specific areas of Mare Island Strait (Figure 17). As can be seen in the table, the hopper samples indicate concentrations of tagged dredged material of as much as 50 percent, with a considerable number of samples showing concentrations of 10-25 percent. These concentrations of tagged dredged material suggest that a certain amount of material was rehandled during the dredging operation and indicate that tagging does permit tracing the dredged sediments.

124. Interpretation of the iridium data from the hopper samples in terms of quantities of material being rehandled may require assuming a uniform distribution of iridium throughout the hopper. Although the sampling technique itself (i.e., immersing a plastic container into hopper sediment) does not permit a measure of accuracy of this assumption, the physical configuration of the loading system ensures good mixing and distribution to both hoppers. As a result, the distribution should be uniform in the lateral and longitudinal directions, but may not be uniform as a function of depth in the hopper.

125. Accidental contamination of the Mare Island Strait or of the hopper samples with iridium-tagged sediments is considered unlikely for the following reasons:

- a. Iridium-tagged sediments were never added to the hoppers until after the dredge had cleared the channel and was approaching the disposal site.
- b. Cleaning the decks was not permitted in the Strait.
- c. No liquid discharge from laundering or other operations was permitted in the channel.
- d. Each sample was collected in a new plastic container removed from its individual wrapper just prior to filling.
- e. After filling, by immersing the container in the hopper sediment, the container was sealed and its outer surface washed with fresh water.
- f. The sediments were spooned out of the container in a

Table 12  
Samples from Hoppers of Dredge Harding During the February-March 1974 Dredging Operations

Date	Time	Location by		Percentage of Dredged Material	Date	Time	Location by		Percentage of Dredged Material
		Channel Section*					Channel Section*		
2/23	AM	Not recorded		0.98	3/13	AM	C&D**		37.14
2/23	PM	Not recorded		4.06	3/13	PM	D		5.34
2/24	PM	Not recorded		2.38	3/14	AM	D		0.0
2/24	AM	A		3.47	3/14	PM	A		8.34
2/25	PM	A		6.74	3/15	AM	B		2.42
2/26	AM	A		4.91	3/15	PM	A		6.04
2/26	PM	A		1.90	3/16	AM	B		3.50
2/27	PM	A		7.51	3/18	AM	F		9.91
2/28	AM	A		2.58	3/19	AM	E		11.39
2/28	PM	A		29.68	3/19	PM	F		25.88
3/1	AM	A		0.0	3/20	AM	F		0.0
3/2	AM	A		5.06	3/20	PM	E		4.05
3/5	AM	F		10.12	3/21	AM	F		26.05
3/5	PM	F		0.0	3/21	PM	F		9.07
3/6	AM	F		49.91	3/22	AM	F		7.55
3/6	PM	F		27.12	3/22	PM	F		3.05
3/7	AM	F		2.64	3/23	AM	E		3.32
3/7	PM	F		41.74	3/24	AM	E		9.25
3/8	AM	E		0.0	3/24	PM	D		3.57
3/8	PM	D		0.44	3/25	PM	D		24.74
3/9	AM	D		0.0	3/26	AM	D		2.61
3/9	PM	E		27.07	3/26	PM	D		5.84
3/10	AM	D		5.13	3/27	AM	C		26.96
3/10	PM	D		5.66	3/27	PM	C		0.42
3/11	AM	D		1.55	3/28	AM	C		14.74
3/11	PM	D		13.38	3/28	PM	C		24.36
3/12	AM	E		2.05	3/29	AM	B		4.33
3/12	PM	D		0.0	3/29	PM	A		23.29

\* Figure 17 shows the channel sections.

\*\* Interface of sections C and D.

COORDINATES	HOLE NO.	LOCATION										
C H 11 B	38	CARQUINEZ STRAIT										
SAMPLING DATES	15MAR74	29MAR74	23APR74	9MAY74	17JUN74	29JUL74	28AUG74	13SEP74	15OCT74	13NOV74	12DEC74	
DEPTH OF SEDIMENT BELOW MLW (FT)	45.0	44.0	44.0	44.0	43.0	43.0	43.0	43.0	43.0	43.5	43.0	
THICKNESS OF LAYERS (IN)												
FLUFF	0.3	-NA-	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	
ACTIVE	16.0	-NA-	5.0	5.0	9.0	5.0	5.0	5.0	8.0	6.0	2.0	
INACTIVE	0.0	-NA-	16.0	12.0	6.0	4.0	12.0	16.0	15.0	20.0	26.0	
SAMPLE A	1007	3907		1411	1825	2182	2461	2647	3007	3208	3400	
G DRY/CC WET MUD	0.379	0.773	LOST	0.764	0.989	0.658	0.780	1.015	0.519	0.622	0.742	
G IR/G DRY MUD	2.26E-08	2.01E-10	SAMPLE 6	0.05E-10	2.35E-10	-BDL-	1.31E-10	9.03E-11	9.25E-10	-BDL-	1.94E-09	
Σ DREDGE MATERIAL	114.230	0.000		1.481	0.000	0.000	0.000	0.000	3.124	0.000	8.344	
SAMPLE B	4660	3908	4854	1412	1826	2183	2462	2648	3008	3209	3401	
G DRY/CC WET MUD	0.767	0.586	0.478	0.716	0.825	0.762	0.688	0.501	0.554	0.814	0.601	
G IR/G DRY MUD	2.91E-10	3.88E-11	6.64E-10	5.55E-10	2.67E-10	1.89E-10	-BDL-	-BDL-	9.92E-10	6.59E-11	3.86E-10	
Σ DREDGE MATERIAL	0.000	0.000	1.784	1.224	0.000	0.000	0.000	0.000	3.465	0.000	0.557	
SAMPLE C	4661	3909	4855	1413	1827	2184	2463	2649	3009	3210	3402	
G DRY/CC WET MUD	0.802	0.629	0.543	0.749	0.801	0.892	0.748	0.788	0.652	0.775	0.634	
G IR/G DRY MUD	1.29E-10	8.58E-12	5.88E-10	1.43E-09	4.13E-10	5.41E-10	5.14E-10	3.01E-11	-BDL-	3.65E-11	3.09E-10	
Σ DREDGE MATERIAL	0.000	0.000	1.393	5.694	0.498	1.153	1.015	0.000	0.000	0.000	0.000	
SAMPLE D	4662	4869	4851	4272	4274	4276	4278					
G DRY/CC WET MUD	0.810	0.526	0.732	0.737	0.640	0.724	0.699					
G IR/G DRY MUD	-BDL-	-BDL-	1.99E-10	5.99E-10	6.61E-10	9.73E-10	1.35E-09					
Σ DREDGE MATERIAL	0.000	0.000	0.000	1.449	1.768	3.371	5.344					
SAMPLE E	4663	4870	4852	4273	4275	4279						
G DRY/CC WET MUD	0.789	0.538	0.527	0.747	0.730	0.623						
G IR/G DRY MUD	-BDL-	1.28E-10	5.47E-11	2.28E-09	5.15E-10	7.83E-10						
Σ DREDGE MATERIAL	0.000	0.000	0.000	10.082	1.023	2.395						
SAMPLE F	4664	4871	4853			4277						
G DRY/CC WET MUD	0.679	0.538	0.543			0.685						
G IR/G DRY MUD	-BDL-	3.41E-10	1.13E-10			7.56E-10						
Σ DREDGE MATERIAL	0.000	0.129	0.000			2.259						
SAMPLE G	4665	4872										
G DRY/CC WET MUD	0.681	0.535										
G IR/G DRY MUD	1.60E-10	4.03E-10										
Σ DREDGE MATERIAL	0.000	0.447										
SAMPLE H	4666											
G DRY/CC WET MUD	0.864											
G IR/G DRY MUD	3.57E-12											
Σ DREDGE MATERIAL	0.000											
COORDINATES	HOLE NO.	LOCATION										
A F 12 B	40	CARQUINEZ STRAIT										
SAMPLING DATES	15MAR74	29MAR74	16APR74	16MAY74	11JUN74	30JUL74	13AUG74	11SEP74	10OCT74	14NOV74	11DEC74	
DEPTH OF SEDIMENT BELOW MLW (FT)	0.0	1.0	1.0	1.0	1.5	1.0	1.5	2.0	1.5	8.0	8.0	
THICKNESS OF LAYERS (IN)												
FLUFF	0.2	0.4	2.5	1.5	1.0	1.0	1.0	1.0	1.5	0.0	0.0	
ACTIVE	17.0	9.0	8.0	9.0	15.0	14.0	14.0	7.0	8.0	11.0	5.0	
INACTIVE	0.0	8.0	8.0	10.0	3.0	6.0	6.0	6.0	9.0	16.0	16.0	
SAMPLE A	1021	3904	1129	1426	1717	2122	2329	2572	2902	3226	3430	
G DRY/CC WET MUD	0.584	0.730	0.444	0.638	0.588	0.576	0.755	0.682	0.691	0.289	0.432	
G IR/G DRY MUD	7.45E-09	4.14E-10	1.08E-09	3.57E-10	3.59E-10	1.93E-10	2.25E-10	9.83E-11	6.68E-10	2.10E-11	8.87E-10	
Σ DREDGE MATERIAL	36.569	0.503	3.905	0.213	0.219	0.000	0.000	0.000	1.806	0.000	2.930	
SAMPLE B	1022	3905	1130	1427	1718	2123	2330	2573	2903	3227	3431	
G DRY/CC WET MUD	0.630	0.565	0.566	0.604	0.573	0.586	0.612	0.629	0.708	0.490	0.347	
G IR/G DRY MUD	6.50E-09	-BDL-	2.22E-09	7.06E-10	3.07E-10	2.46E-10	3.43E-10	3.53E-10	3.43E-09	2.51E-10	1.75E-09	
Σ DREDGE MATERIAL	31.740	0.000	9.753	2.001	0.000	0.000	0.139	0.190	15.983	0.000	7.359	
SAMPLE C	1023	3906	1131	1428	1719	2124	2331	2574	2904	3228	3432	
G DRY/CC WET MUD	0.642	0.654	0.558	0.551	0.593	0.545	0.632	0.635	0.723	0.578	0.418	
G IR/G DRY MUD	1.30E-08	2.23E-10	1.21E-09	7.27E-10	5.93E-10	1.37E-10	4.38E-10	5.32E-10	1.03E-09	-BDL-	2.05E-10	
Σ DREDGE MATERIAL	64.840	0.000	4.585	2.110	1.423	0.000	0.625	1.108	3.670	0.000	0.000	
SAMPLE D	4356		4529	4286	4288	4290	4292	4294	4295	4756	4758	
G DRY/CC WET MUD	0.616		0.552	0.539	0.641	0.583	0.601	0.641	0.541	0.506	0.434	
G IR/G DRY MUD	3.76E-11		-BDL-	4.82E-10	7.04E-11	6.18E-10	5.91E-10	2.22E-10	2.97E-10	3.48E-10	2.72E-10	
Σ DREDGE MATERIAL	0.000		0.000	0.852	0.000	1.551	1.410	0.000	0.000	0.164	0.000	
SAMPLE E	4357				4289	4291					4759	
G DRY/CC WET MUD	0.577				0.603	0.629					0.520	
G IR/G DRY MUD	3.64E-10				9.63E-11	2.22E-10					1.71E-10	
Σ DREDGE MATERIAL	0.245				0.000	0.000					0.000	
SAMPLE F			4530	4287			4293		4296	4757		
G DRY/CC WET MUD			0.615	0.572			0.709		0.642	0.525		
G IR/G DRY MUD			3.51E-10	2.56E-10			2.33E-10		4.47E-10	4.37E-10		
Σ DREDGE MATERIAL			0.178	0.000			0.000		0.670	0.622		
SAMPLE G												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												

Figure 18. Data sheets for holes 38 and 40, Carquinez Strait

COORDINATES	HOLE NO.	LOCATION										
F E S S	53	PINOLE SHOAL										
SAMPLING DATES	22MAR74	3APR74	13MAY74	3JUN74	31JUL74	23AUG74	4SEP74	9OCT74	6NOV74	4DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)	18.5	19.0	18.5	21.5	21.0	21.5	21.5	21.0	21.5	22.0		
THICKNESS OF LAYERS (IN)												
FLUFF	0.2	0.5	1.5	2.0	0.0	0.0	1.0	1.5	0.0	0.0		
ACTIVE	11.0	10.0	9.0	7.0	14.0	3.0	6.0	5.0	6.0	2.0		
INACTIVE	8.0	12.0	15.0	8.0	0.0	18.0	13.0	8.0	23.0	20.0		
SAMPLE A	3853	3928	1441	1591	2149	2452	2524	2866	3193	3529		
G DRY/CC WET MUD	0.522	0.673	0.812	0.682	0.716	1.178	0.887	0.774	0.461	0.650		
G IR/G DRY MUD	4.25E-09	-BOL-	3.77E-10	2.91E-10	3.64E-10	-BOL-	4.55E-10	1.52E-11	5.02E-10	3.77E-10		
Σ DREDGE MATERIAL	20.177	0.000	0.313	0.000	0.247	0.000	0.711	0.000	0.954	0.311		
SAMPLE B	3854	3929	1442	1592	2150	2453	2525	2867	3194	3530		
G DRY/CC WET MUD	0.492	0.470	0.623	0.874	0.615	0.866	0.721	0.656	0.676	0.620		
G IR/G DRY MUD	6.76E-10	2.83E-10	3.51E-10	5.97E-10	4.54E-10	3.45E-10	9.84E-11	-BOL-	4.85E-11	-BOL-		
Σ DREDGE MATERIAL	1.845	0.000	0.178	1.441	0.708	0.151	0.000	0.000	0.000	0.000		
SAMPLE C	3855	3930	1443	1593	2151	2454	2526	2868	3195	3531		
G DRY/CC WET MUD	0.944	0.724	0.527	1.004	0.668	0.758	0.702	0.922	0.703	0.660		
G IR/G DRY MUD	1.13E-09	-BOL-	6.74E-10	2.06E-09	7.00E-10	1.45E-10	-BOL-	1.71E-10	4.85E-11	6.70E-11		
Σ DREDGE MATERIAL	4.191	0.000	1.838	8.949	1.970	0.000	0.000	0.000	0.000	0.000		
SAMPLE D			4386	0513	4388							
G DRY/CC WET MUD			0.689	0.823	0.671							
G IR/G DRY MUD			1.85E-10	5.75E-10	1.28E-10							
Σ DREDGE MATERIAL			0.000	1.330	0.000							
SAMPLE E												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE F												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
COORDINATES	HOLE NO.	LOCATION										
A F I N S	107	SUISUN BAY										
SAMPLING DATES	23APR74	16MAY74	17JUN74	29JUL74	13AUG74	11SEP74	10OCT74	13NOV74	11DEC74			
DEPTH OF SEDIMENT BELOW MLLW (FT)	35.0	33.0	24.5	27.0	27.0	27.0	28.0	27.5	28.0			
THICKNESS OF LAYERS (IN)												
FLUFF	-NA-	0.0	1.5	2.0	0.5	0.0	2.0	0.0	0.0			
ACTIVE	-NA-	18.0	6.0	3.0	6.0	1.0	9.0	7.0	2.0			
INACTIVE	-NA-	0.0	6.0	5.0	6.0	12.0	8.0	7.0	14.0			
SAMPLE A	1438	1822	2176	2380	2659	2974	3214	3436				
G DRY/CC WET MUD	NO	0.798	0.894	0.579	1.004	0.525	0.645	0.592	0.590			
G IR/G DRY MUD	SAMPLE 7.78E-10	1.67E-10	3.02E-10	1.85E-10	2.60E-10	1.11E-09	1.86E-10	6.88E-10				
Σ DREDGE MATERIAL	2.367	0.000	0.000	0.000	0.000	4.072	0.000	1.908				
SAMPLE B	1439	1823	2177	2381	2660	2975	3215	3437				
G DRY/CC WET MUD	NO	0.608	1.513	0.672	0.503	0.671	0.594	0.799	0.217			
G IR/G DRY MUD	SAMPLE 7.91E-10	1.67E-10	2.05E-10	3.74E-10	4.93E-10	1.77E-09	5.65E-11	1.03E-10				
Σ DREDGE MATERIAL	2.437	0.000	0.000	0.298	0.908	7.444	0.000	0.000				
SAMPLE C	1440	1824	2178	2382	2661	2976	3216	3438				
G DRY/CC WET MUD	NO	0.575	1.337	0.709	0.260	0.749	0.592	0.875	0.350			
G IR/G DRY MUD	SAMPLE 1.34E-09	1.13E-10	3.77E-10	1.02E-10	4.35E-10	1.40E-09	-BOL-	6.15E-10				
Σ DREDGE MATERIAL	5.256	0.000	0.313	0.000	0.608	5.537	0.000	1.533				
SAMPLE D		4612					4614	4886				
G DRY/CC WET MUD		0.834					0.603	0.650				
G IR/G DRY MUD		5.78E-10					-BOL-	8.71E-10				
Σ DREDGE MATERIAL		1.342					0.000	2.848				
SAMPLE E		4613										
G DRY/CC WET MUD		0.928										
G IR/G DRY MUD		3.39E-10										
Σ DREDGE MATERIAL		0.117										
SAMPLE F												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												

Figure 19. Data sheets for hole 53, Pinole Shoal, and for hole 107, Suisun Bay

COORDINATES		HOLE NO	LOCATION											
E	H	6	B	59	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES					2APR74	2MAY74	4JUN74	9JUL74	2AUG74	3SEP74	17OCT74	29NOV74	13DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)					10.0	8.5	8.5	8.0	9.0	7.5	8.5	9.0	8.5	
THICKNESS OF LAYERS (IN)														
FLUFF					0.4	1.5	1.5	2.0	3.0	0.0	2.0	0.0	2.0	
ACTIVE					20.0	8.0	6.0	5.0	6.0	5.0	7.0	5.0	6.0	
INACTIVE					0.0	5.0	12.0	11.0	15.0	9.0	14.0	12.0	17.0	
SAMPLE A					3922	1297	1603	1894	2203	2476	3022	3101	3364	
G DRY/CC WET MUD					0.674	0.697	0.746	0.687	0.696	0.836	0.659	0.549	0.494	
G IR/G DRY MUD					5 31E-11	1.61E-10	2 39E-10	3 96E-10	1 53E-10	2 68E-10	5 49E-10	2 00E-10	2 80E-10	
1 DREDGE MATERIAL					0.000	0.000	0.000	0.412	0.000	0.000	1.193	0.000	0.000	
SAMPLE B					3923	1298	1604	1895	2204	2477	3023	3104	3365	
G DRY/CC WET MUD					0.382	0.666	0.500	0.524	0.630	0.692	0.564	0.790	0.493	
G IR/G DRY MUD					-BOL-	2.95E-10	2 67E-10	4 95E-10	2 92E-11	1 09E-10	1 08E-08	2 71E-10	3 03E-10	
1 DREDGE MATERIAL					0.000	0.000	0.000	0.919	0.000	0.000	5.1621	0.000	0.000	
SAMPLE C					3924	1299	1605	1896	2205	2478	3024	3105	3366	
G DRY/CC WET MUD					0.474	0.529	0.516	0.628	0.513	0.670	0.553	0.784	0.590	
G IR/G DRY MUD					4 83E-10	4 48E-10	9 21E-10	4 72E-10	3 74E-10	1 59E-10	8 50E-10	1 87E-10	1 92E-09	
1 DREDGE MATERIAL					0.054	0.677	3.103	0.803	0.298	0.000	2.739	0.000	8.224	
SAMPLE D						4404	4642	4406					4783	
G DRY/CC WET MUD						0.584	0.711	0.569					0.647	
G IR/G DRY MUD						-BOL-	2 54E-10	1 24E-10					1 32E-10	
1 DREDGE MATERIAL						0.000	0.000	0.000					0.000	
SAMPLE E						4405	4643	4407					4784	
G DRY/CC WET MUD						0.495	0.617	0.706					0.634	
G IR/G DRY MUD						2 28E-10	4 99E-10	4 28E-10					4 40E-10	
1 DREDGE MATERIAL						0.000	0.941	0.576					0.636	
SAMPLE F														
G DRY/CC WET MUD														
G IR/G DRY MUD														
1 DREDGE MATERIAL														
SAMPLE G														
G DRY/CC WET MUD														
G IR/G DRY MUD														
1 DREDGE MATERIAL														
SAMPLE H														
G DRY/CC WET MUD														
G IR/G DRY MUD														
1 DREDGE MATERIAL														

COORDINATES		HOLE NO	LOCATION											
E	H	4	S	71	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES					12APR74	10MAY74	7JUN74	22JUL74	8AUG74	5SEP74	15OCT74	29NOV74	17DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)					7.5	6.0	6.5	6.5	7.0	6.5	6.5	7.0	7.0	
THICKNESS OF LAYERS (IN)														
FLUFF					1.0	1.0	2.0	0.0	0.5	0.0	2.0	0.0	1.0	
ACTIVE					10.0	8.0	16.0	3.0	14.0	8.0	6.0	2.0	4.0	
INACTIVE					11.0	12.0	5.0	9.0	3.0	3.0	9.0	20.0	12.0	
SAMPLE A					1147	1417	1663	2020	2230	2560	2986	3262	3613	
G DRY/CC WET MUD					0.391	0.635	0.629	0.560	0.580	0.805	0.530	0.507	0.613	
G IR/G DRY MUD					7 25E-10	5 14E-10	2 38E-10	3 10E-10	2 74E-10	3 77E-10	6 13E-10	4 63E-11	9 94E-10	
1 DREDGE MATERIAL					2.097	1.013	0.000	0.000	0.000	0.310	1.525	0.000	3.476	
SAMPLE B					1148	1418	1664	2021	2231	2561	2987	3263	3614	
G DRY/CC WET MUD					0.587	0.567	0.583	0.537	0.659	0.878	0.562	0.600	0.526	
G IR/G DRY MUD					7 69E-10	1 05E-09	2 15E-10	2 40E-10	1 05E-10	8 24E-10	5 67E-10	1 35E-10	2 36E-10	
1 DREDGE MATERIAL					2.321	3.785	0.000	0.000	0.000	2.604	1.287	0.000	0.000	
SAMPLE C					1149	1419	1665	2022	2232	2562	2988	3264	3615	
G DRY/CC WET MUD					0.527	0.643	0.524	0.809	0.657	0.720	0.660	0.702	0.636	
G IR/G DRY MUD					5 15E-10	5 90E-10	8 69E-10	1 50E-10	-BOL-	3 33E-10	-BOL-	3 77E-10	4 70E-10	
1 DREDGE MATERIAL					1.021	1.406	2.836	0.000	0.000	0.089	0.000	0.313	0.798	
SAMPLE D						4454			4455	4457	4458	4461	4469	
G DRY/CC WET MUD						0.679			0.824	0.875	0.889	0.602	0.588	
G IR/G DRY MUD						5 45E-10			6 01E-10	-BOL-	-BOL-	0.300E+00	1 67E-10	
1 DREDGE MATERIAL						1.175			1.461	0.000	0.000	0.000	0.000	
SAMPLE E									4456		4459		4460	
G DRY/CC WET MUD									0.811		0.718		0.589	
G IR/G DRY MUD									4 10E-10		-BOL-		1 63E-10	
1 DREDGE MATERIAL									0.482		0.000		0.242	
SAMPLE F														
G DRY/CC WET MUD														
G IR/G DRY MUD														
1 DREDGE MATERIAL														
SAMPLE G														
G DRY/CC WET MUD														
G IR/G DRY MUD														
1 DREDGE MATERIAL														
SAMPLE H														
G DRY/CC WET MUD														
G IR/G DRY MUD														
1 DREDGE MATERIAL														

Figure 20. Data sheets for holes 59, 71, 89, and 101, San Pablo Bay Flats (sheet 1 of 2)

COORDINATES	HOLE NO.	LOCATION								
J E 2 5	89	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES	18APR74	21MAY74	18JUN74	18JUL74	14AUG74	12SEP74	30CT74	12NOV74	9DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	4.5	5.0	5.0	5.5	5.5	5.5	5.5	5.0	5.0	
THICKNESS OF LAYERS (IN)										
FLUFF	0.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	1.0	
ACTIVE	9.0	7.0	7.0	1.0	9.0	8.0	6.0	8.0	7.0	
INACTIVE	10.0	7.0	7.0	12.0	5.0	12.0	12.0	16.0	19.0	
SAMPLE A	1186	1480	1840	1951	2344	2599	2788	3205	3418	
G DRY/CC WET MUD	0.626	0.595	0.851	0.715	0.855	0.790	0.741	0.619	0.710	
G IR/G DRY MUD	6.83E-10	4.06E-10	2.37E-10	4.1E-10	-BDL-	2.54E-10	6.87E-11	1.14E-09	3.75E-10	
1 DREDGE MATERIAL	1.882	0.463	0.000	3.206	0.000	0.000	0.000	4.246	0.301	
SAMPLE B	1187	1481	1841	1952	2345	2600	2789	3206	3419	
G DRY/CC WET MUD	0.635	0.641	0.722	0.740	0.851	0.663	0.593	0.637	0.888	
G IR/G DRY MUD	7.21E-10	2.60E-10	5.69E-10	8.84E-10	1.92E-10	2.04E-10	1.91E-11	4.74E-10	2.44E-09	
1 DREDGE MATERIAL	2.076	0.000	1.298	2.912	0.000	0.000	0.000	0.811	10.909	
SAMPLE C	1188	1482	1842	1953	2346	2601	2790	3207	3420	
G DRY/CC WET MUD	0.651	0.594	0.604	0.604	0.687	0.703	0.686	0.682	0.724	
G IR/G DRY MUD	3.75E-10	6.59E-10	1.07E-10	7.07E-10	1.47E-10	5.55E-10	-BDL-	5.25E-10	8.53E-10	
1 DREDGE MATERIAL	0.303	1.759	0.000	2.006	0.000	1.223	0.000	1.074	2.752	
SAMPLE D	4513	4543	4545			4546		4766	4764	
G DRY/CC WET MUD		0.576	0.584	0.554		0.617		0.624	0.717	
G IR/G DRY MUD		2.95E-10	-BDL-	7.69E-11		-BDL-		1.21E-10	3.39E-10	
1 DREDGE MATERIAL		0.000	0.000	0.000		0.000		0.000	0.000	
SAMPLE E	4544									
G DRY/CC WET MUD	0.711									
G IR/G DRY MUD	1.22E-10									
1 DREDGE MATERIAL	0.000									
SAMPLE F						4547		4767	4765	
G DRY/CC WET MUD						0.610		0.554	0.630	
G IR/G DRY MUD						4.07E-10		3.65E-10	3.79E-10	
1 DREDGE MATERIAL						0.466		0.253	0.324	
SAMPLE G										
G DRY/CC WET MUD										
G IR/G DRY MUD										
1 DREDGE MATERIAL										
SAMPLE H										
G DRY/CC WET MUD										
G IR/G DRY MUD										
1 DREDGE MATERIAL										

COORDINATES	HOLE NO.	LOCATION								
J C 4 3	101	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES	25APR74	22MAY74	13JUN74	22JUL74	14AUG74	9SEP74	4OCT74	23NOV74	9DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	5.0	5.0	5.0	5.5	6.0	5.5	5.0	5.5	5.5	
THICKNESS OF LAYERS (IN)										
FLUFF	1.0	3.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	
ACTIVE	5.0	8.0	6.0	7.0	8.0	10.0	7.0	17.0	2.0	
INACTIVE	9.0	6.0	12.0	9.0	4.0	11.0	8.0	3.0	16.0	
SAMPLE A	1222	1534	1753	1987	2347	2569	2944	3271	3409	
G DRY/CC WET MUD	0.520	0.453	0.724	0.756	0.680	0.737	0.655	0.471	0.660	
G IR/G DRY MUD	9.03E-10	3.38E-10	3.72E-10	5.78E-10	1.29E-10	1.75E-10	1.97E-09	4.17E-10	3.40E-10	
1 DREDGE MATERIAL	3.011	0.113	0.288	1.342	0.000	0.000	8.479	0.518	0.123	
SAMPLE B	1223	1535	1754	1988	2348	21.0	2945	3272	3410	
G DRY/CC WET MUD	0.657	0.703	0.664	0.661	0.649	0.641	0.655	0.584	0.619	
G IR/G DRY MUD	2.80E-09	3.68E-10	4.30E-10	5.33E-10	-BDL-	-BDL-	2.54E-09	3.01E-10	2.62E-10	
1 DREDGE MATERIAL	12.751	0.268	0.585	1.111	0.000	0.000	11.392	0.000	0.000	
SAMPLE C	1224	1536	1755	1989	2349	2571	2946	3273	3411	
G DRY/CC WET MUD	0.675	0.767	0.718	0.705	0.676	0.761	0.759	0.799	0.687	
G IR/G DRY MUD	3.66E-09	4.78E-10	5.92E-10	3.93E-10	4.76E-10	4.13E-10	7.40E-10	8.23E-11	-BDL-	
1 DREDGE MATERIAL	17.156	0.830	1.417	0.393	0.921	0.500	2.173	0.000	0.000	
SAMPLE D	4588	4862	4590				4592			
G DRY/CC WET MUD	0.668	0.593	0.743				0.695			
G IR/G DRY MUD	3.07E-10	2.61E-10	8.92E-10				1.50E-09			
1 DREDGE MATERIAL	0.000	0.000	2.953				6.057			
SAMPLE E	4589	4863	4591				4593			
G DRY/CC WET MUD	0.694	0.615	0.740				0.776			
G IR/G DRY MUD	-BDL-	-BDL-	2.16E-10				-BDL-			
1 DREDGE MATERIAL	0.000	0.000	0.000				0.000			
SAMPLE F										
G DRY/CC WET MUD										
G IR/G DRY MUD										
1 DREDGE MATERIAL										
SAMPLE G										
G DRY/CC WET MUD										
G IR/G DRY MUD										
1 DREDGE MATERIAL										
SAMPLE H										
G DRY/CC WET MUD										
G IR/G DRY MUD										
1 DREDGE MATERIAL										

Figure 20 (sheet 2 of 2)

manner that ensured that the analytical sample would not be accidentally contaminated by any iridium that might have been deposited on the outside of the plastic container.

#### Test area samples

126. Data sheets for sampling locations (holes) in various parts of the test area are shown in Figures 18-20. Examination of the data reveals that the depth of sediment measurement often conflicts with the thickness measurements of fluff, active, and inactive layers as previously defined. That is, from month to month the measured changes in depth of sediment cannot be correlated with corresponding changes in the measured sediment layers. Reference 10 discusses this conflict.

127. With regard to the other entries on the data sheets, because iridium concentration was determined on a dry-weight basis, it was necessary to measure an in-place or bulk density in units of grams of dry sediment per cubic centimetre of wet sediment. The reported density measurements have a wide range of values. Some of this variation may result from the difficulty of physically removing a specified volume from the core sample as received; that is, marking 25.4 mm (1 in.) of sediment on a 762-mm (30-in.) column, removing the water above the sediment, and then spooning out the sediment to a 25.4-mm (1-in.) depth.

128. The numerical values for the iridium concentration (g Ir/g of dry sediment) probably contain a small experimental error when compared with the uncertainties involved in some of the other steps of the tracer program. Several sets of data were obtained from replicate fire-assayed tests of sediments with known iridium concentrations. Statistical analysis of these data always resulted in a coefficient of variation of less than 10 percent. The overall experimental error for the sampling and laboratory operations was not determined and probably could not be measured because so many steps in the operations could not be controlled. However, many of these errors are compensating, and the large number of samples, almost 4000, increases the credibility of the final results.

129. The value for the percentage of dredge material discussed previously was determined by dividing the measured iridium concentration

by the theoretical iridium concentration applied to the tagged sediments, assuming that all the iridium was uniformly fixed to the tagged dredged sediments which were uniformly mixed in each hopper released. A few values greater than 100 percent were obtained possibly as the result of nonuniform mixing of the iridium with the dredge sediments. Then too, as suggested by the hopper samples, since rehandling of previously dredged tagged sediment yielded an initial iridium content, the usual tagged sediment addition resulted in an iridium concentration higher than the theoretical concentration described above.

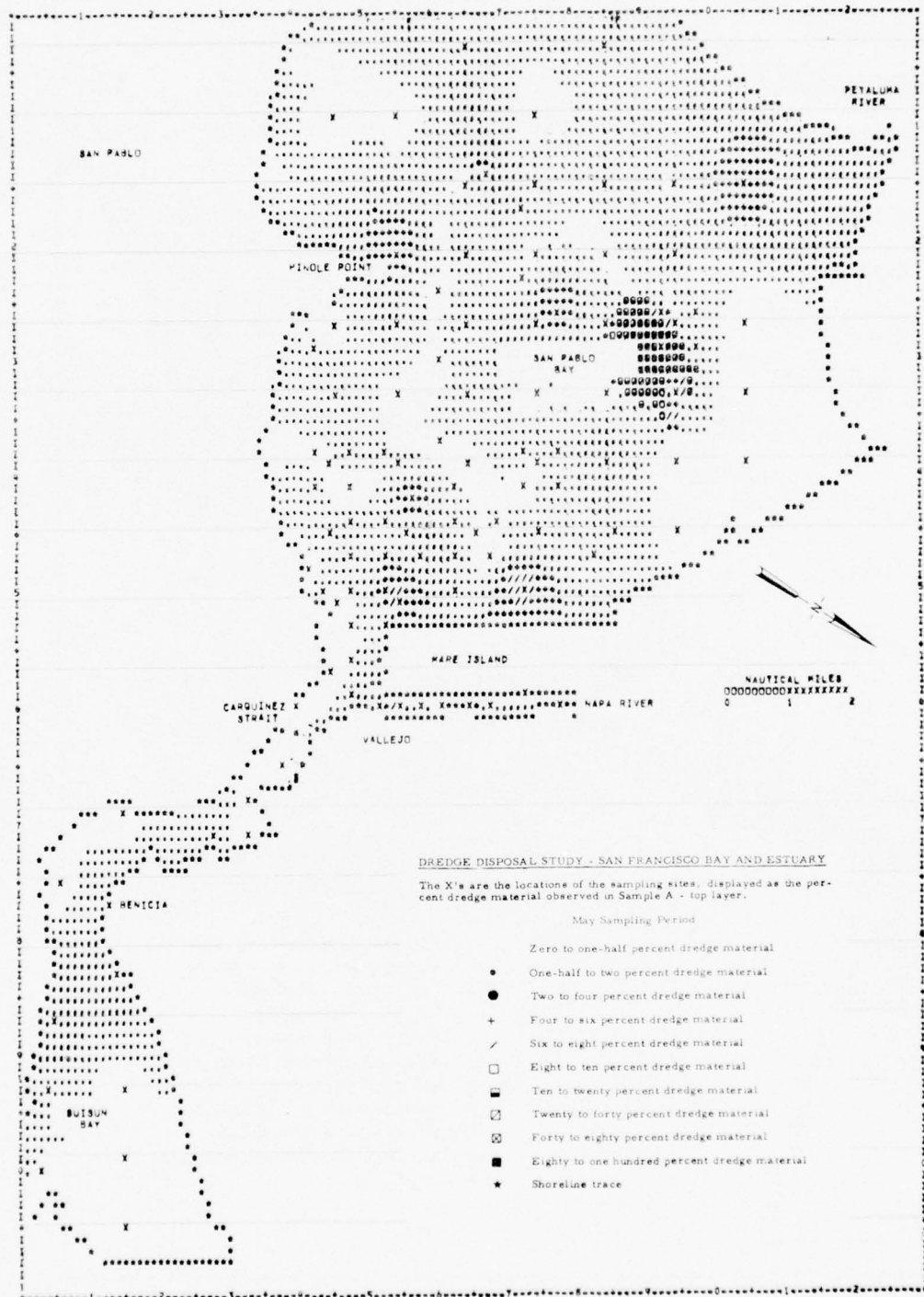
130. The large number of data points obtained from the grid pattern was a challenging problem in analysis and presentation. The solution was the creation of a series of computer-prepared graphic displays\* of the test area showing the distribution of the tagged sediments over space and time. Figures 21, 22, and 23 show the sediment distribution for May, August, and October 1974 as follows:

<u>Sediment Layer</u>	<u>May</u>	<u>August</u>	<u>October</u>
Layer A 0-25.4 mm (0-1 in.)	Figure 21a	Figure 22a	Figure 23a
Layer B 25.4-127 mm (1-5 in.)	Figure 21b	Figure 22b	Figure 23b
Layer C 127-229 mm (5-9 in.)	Figure 21c	Figure 22c	Figure 23c

131. The displays for May indicate that traced dredged sediments had circulated to all parts of the test area and were deposited at the three sample depths. In contrast, the August presentations show that in the first 229 mm (9 in.) of sediment in many parts of the test area there were essentially no traced dredged materials; while in the areas where traced dredged materials were present, their concentration was lower than those in the May period. In October a dramatic increase in the concentration of traced dredged sediments in each of the three layers was noted as compared with the August displays. This increase

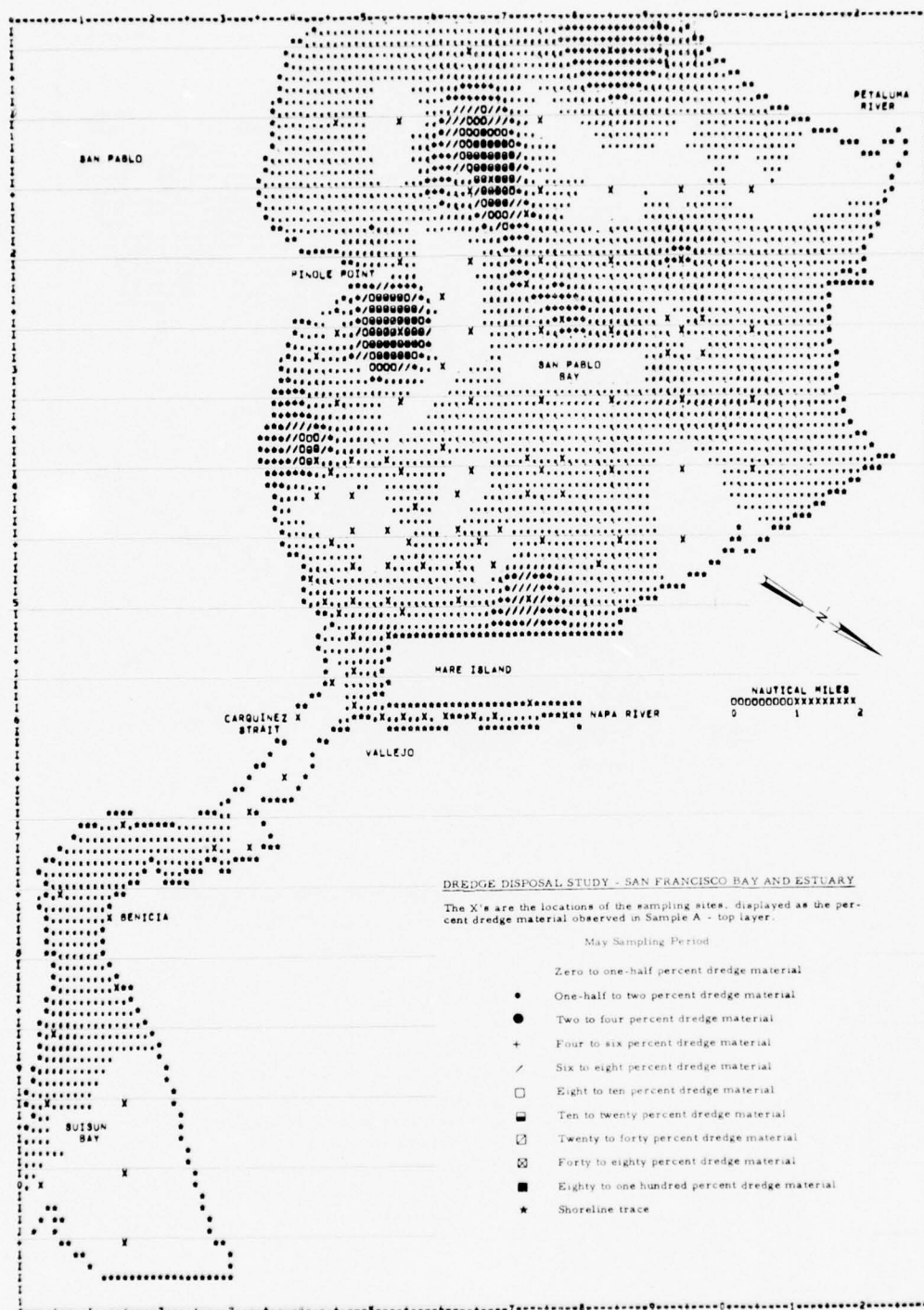
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\* The plots were prepared by the U. S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California.



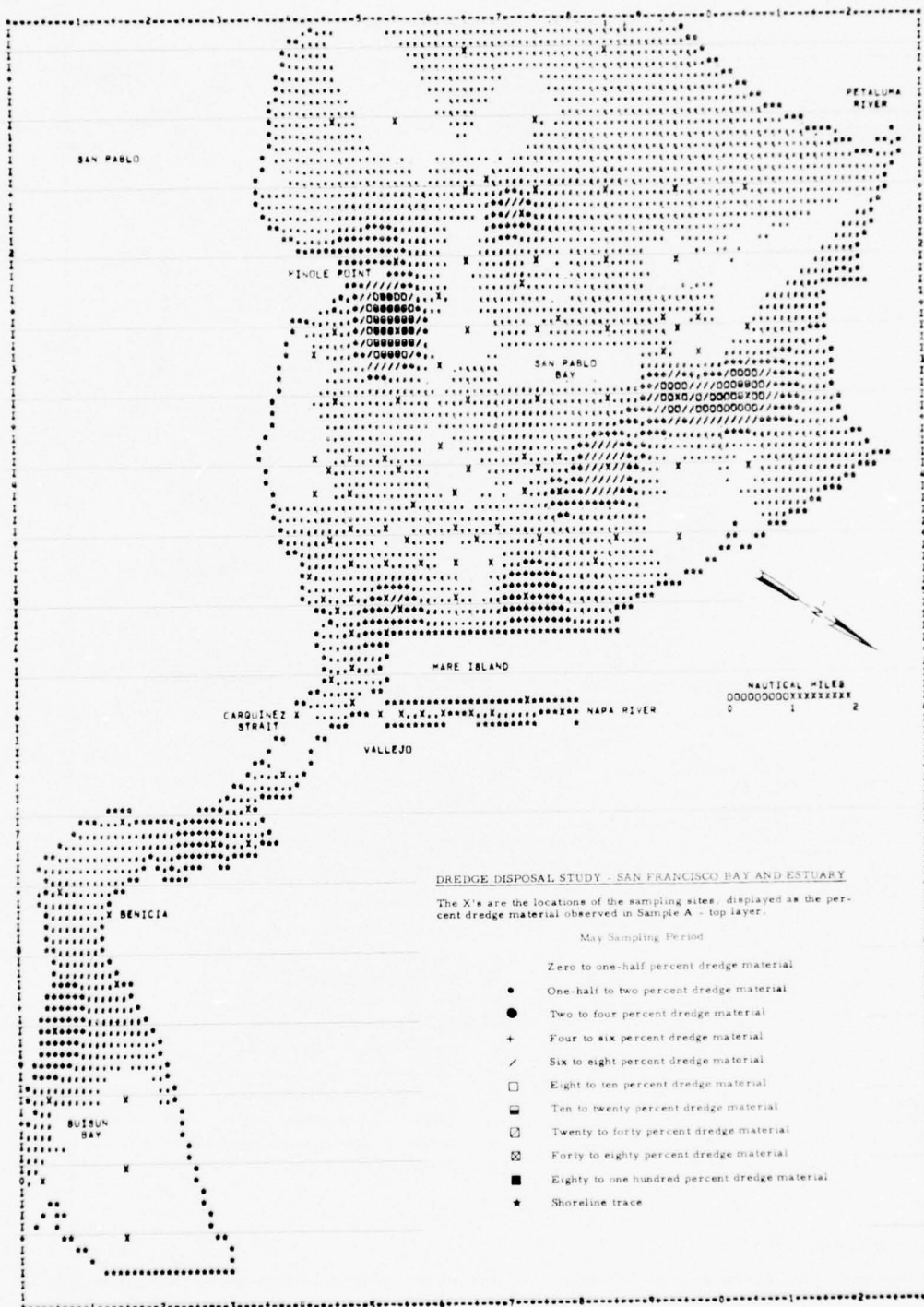
a. Layer A (0-25.4 mm)

Figure 21. May sampling period (sheet 1 of 3)



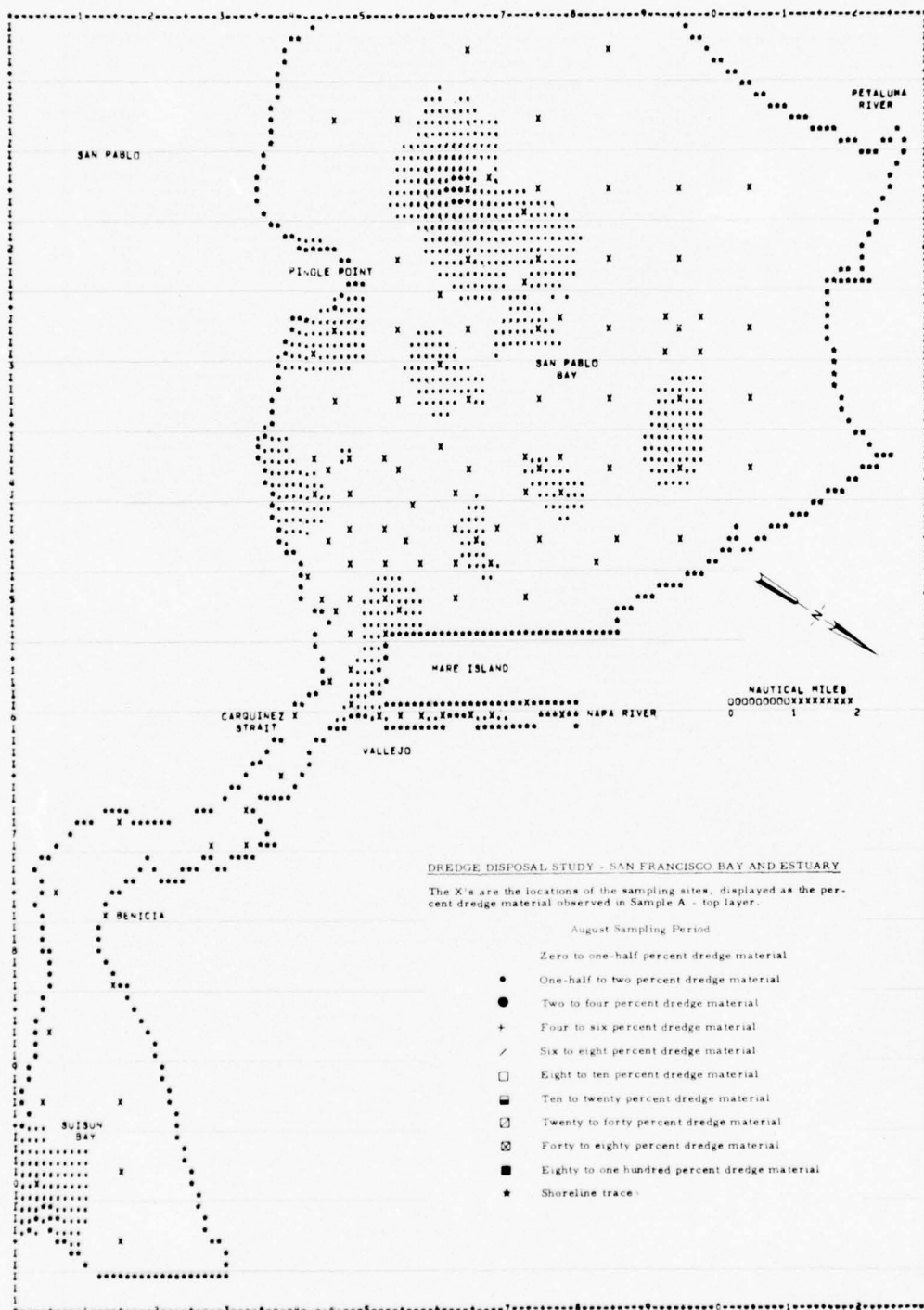
b. Layer B (25.4-127 mm)

Figure 21 (sheet 2 of 3)



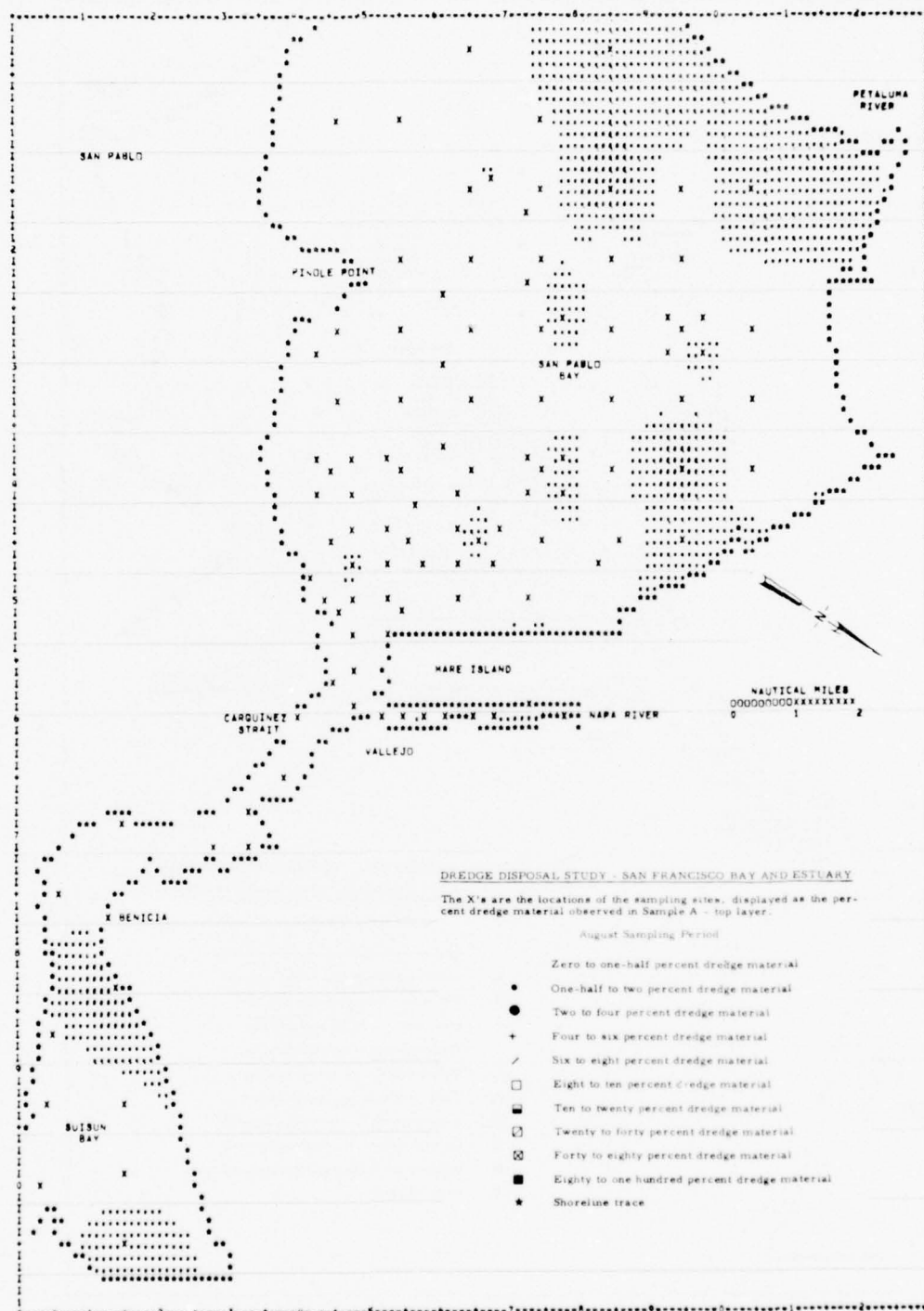
c. Layer C (127-228.6 mm)

Figure 21 (sheet 3 of 3)



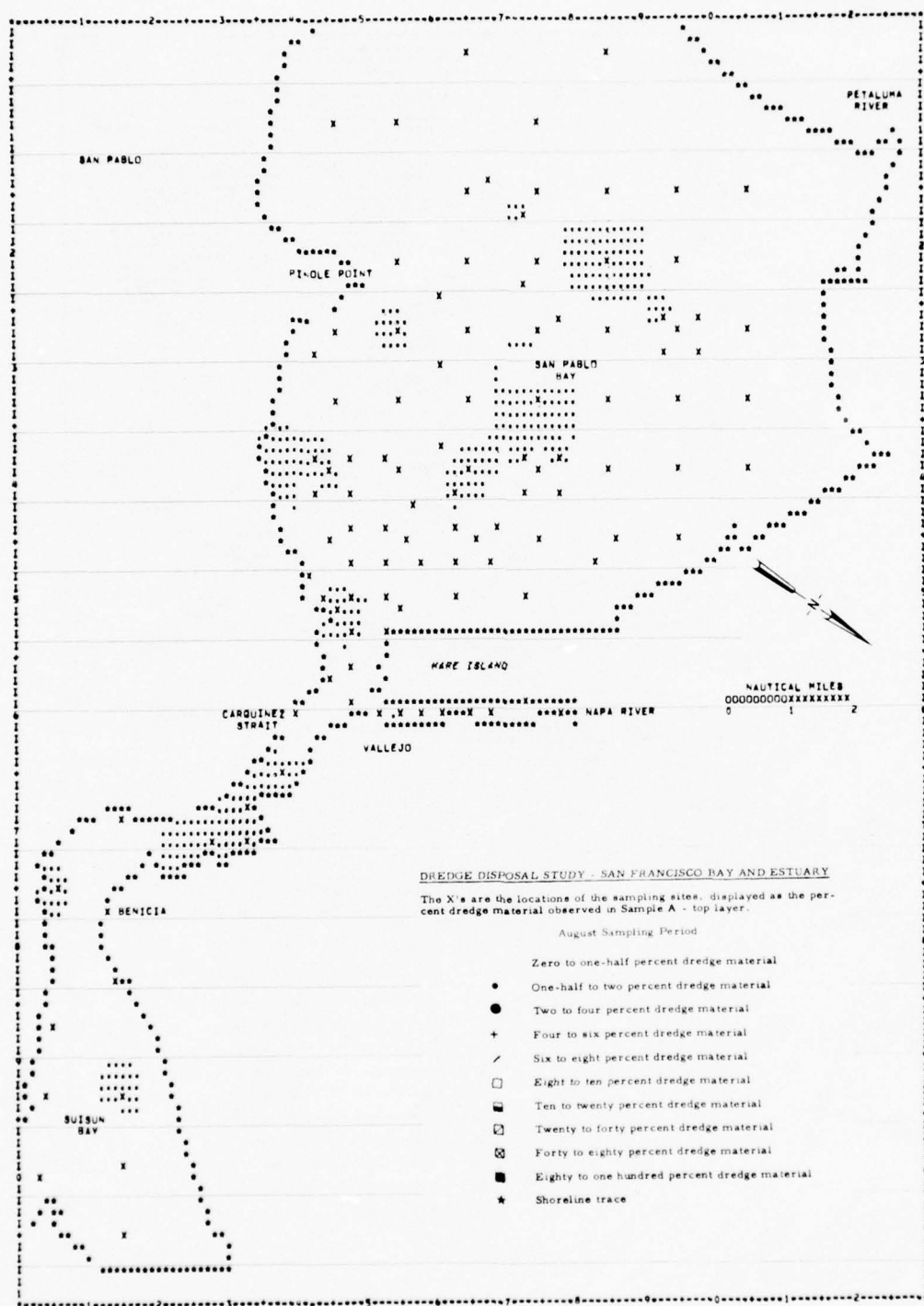
a. Layer A (0-25.4 mm)

Figure 22. August sampling period (sheet 1 of 3)



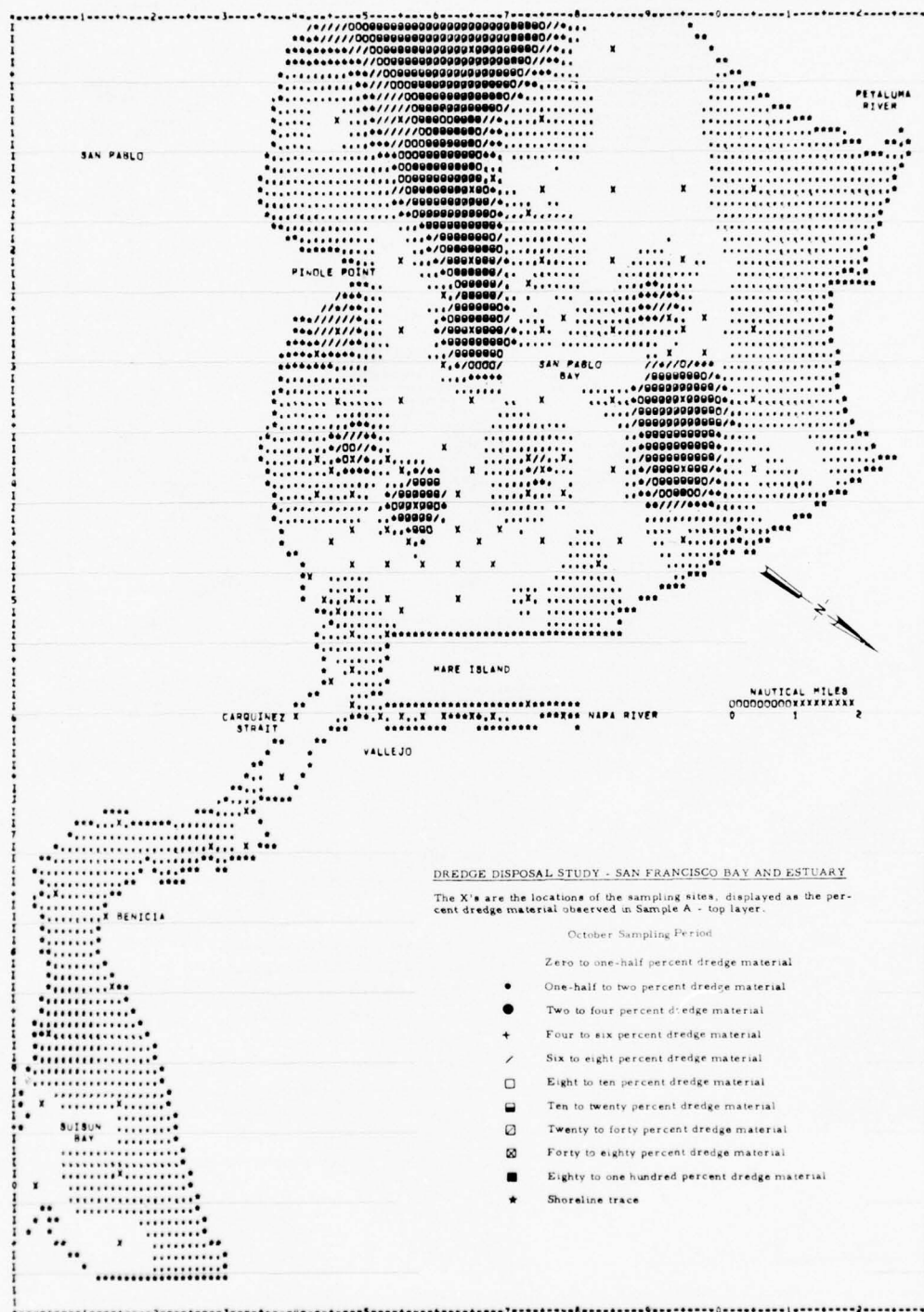
b. Layer B (25.4-127 mm)

Figure 22 (sheet 2 of 3)



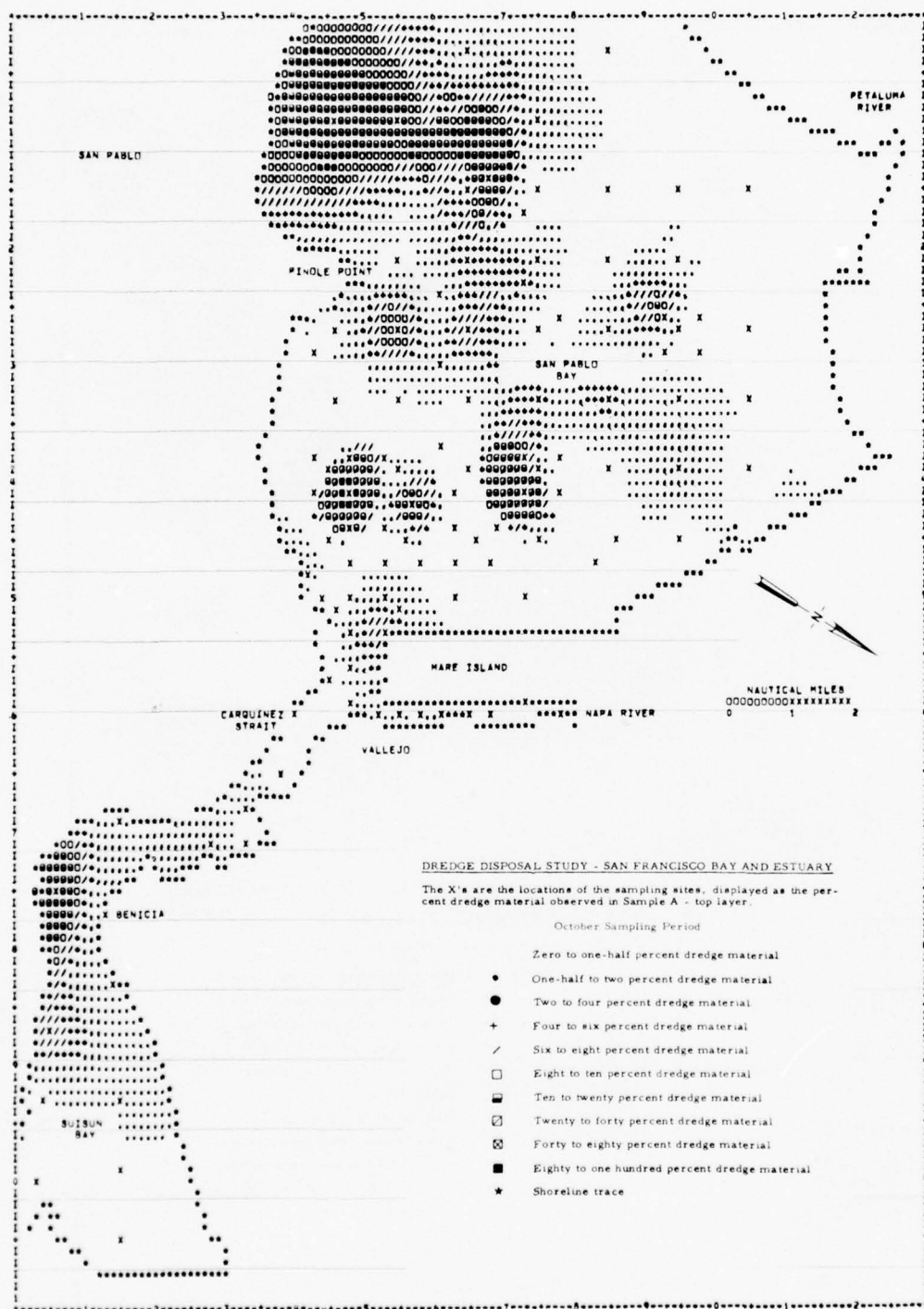
c. Layer C (127-228.6 mm)

Figure 22 (sheet 3 of 3)



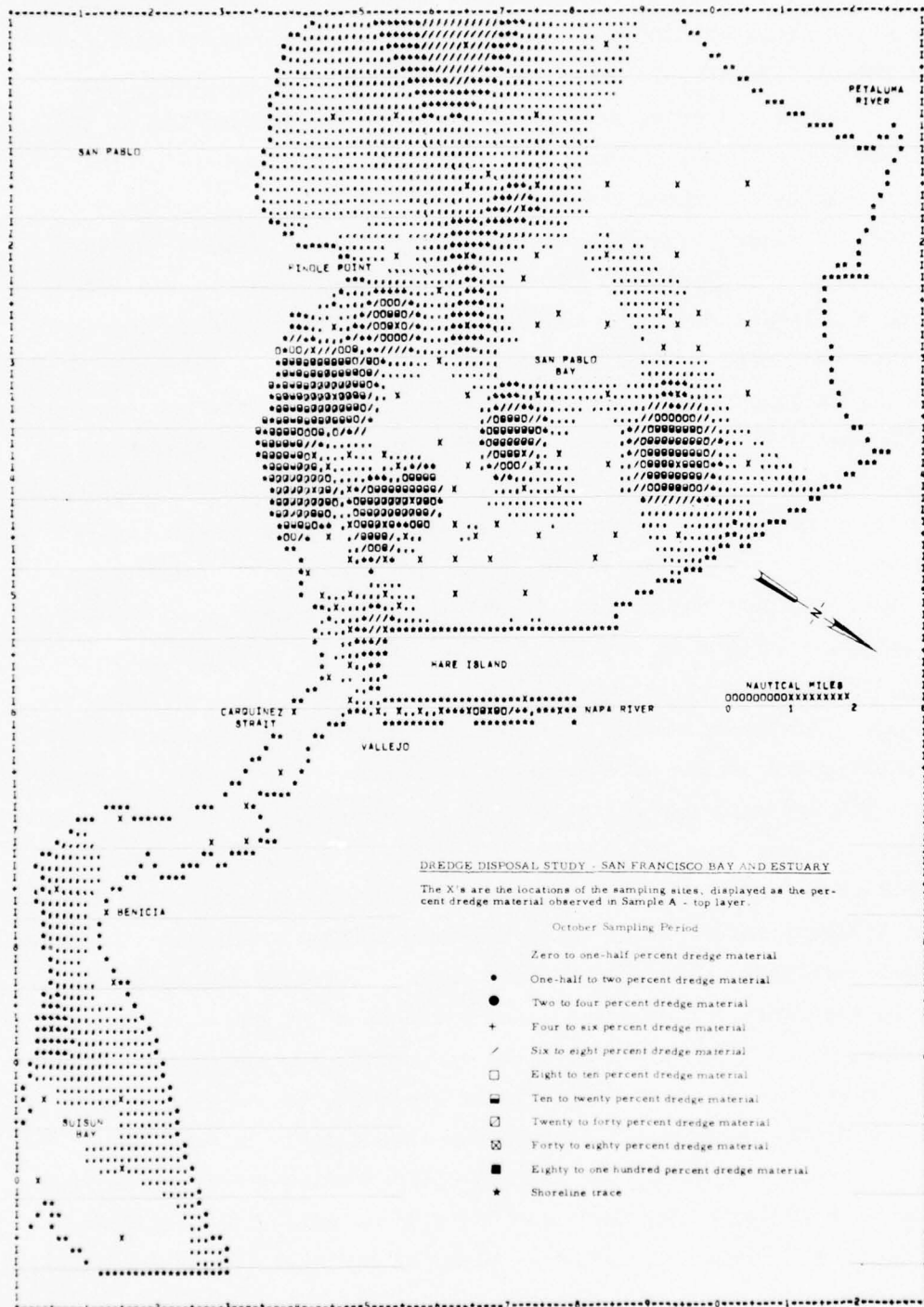
a. Layer A (0-25.4 mm)

Figure 23. October sampling period (sheet 1 of 3)



b. Layer B (25.4-127 mm)

Figure 23 (sheet 2 of 3)



c. Layer C (127-228.6 mm)

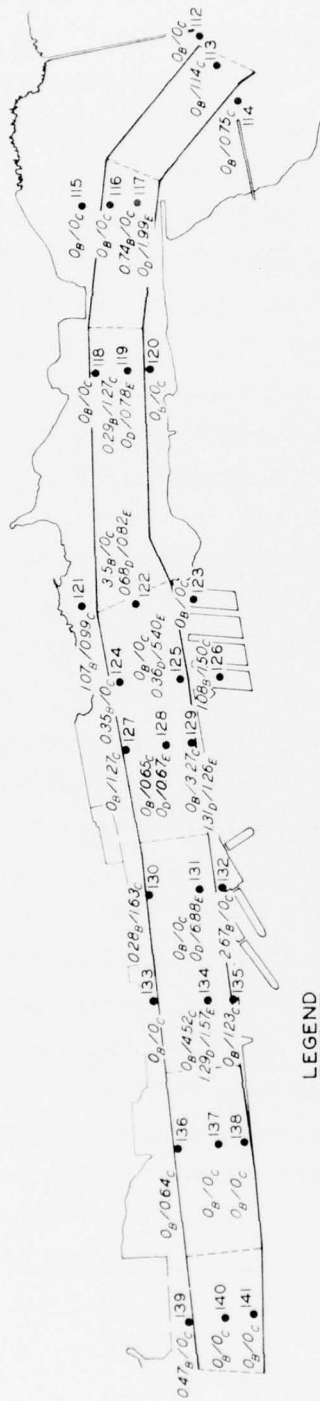
Figure 23 (sheet 3 of 3)

resulted from the September-October 1974 dredging of the Mare Island Strait which redistributed the tagged sediments previously introduced in the February-March 1974 dredging. In the authors' opinions, the October results, occurring seven months after the introduction of the traced sediments, provide conclusive evidence of the success of the sediment tracing technique developed.

132. Similar figures have been plotted (not included) for each month from April to December. In April the traced sediment had circulated to all locations in the test area. The traced sediment concentrations then proceeded to decline through September, as illustrated in the May to August comparison. After the October increase, the concentration decreased again in November and December. These changing patterns can result from tagged particles returning to the Mare Island Strait, tagged particles being carried out of the test area, dilution of the tagged particles with inert particles, or tagged particles being covered by a new layer of inert particles. An attempt will be made to evaluate these separate effects in the San Francisco District report.<sup>10</sup>

#### Mare Island Strait profile samples

133. The locations and iridium concentrations of the profile samples collected in the Mare Island Strait just prior to the September-October 1974 dredging operation is shown in Figure 24. Concentrations of traced dredged materials are given for layers B and C and, where available, for layers D and E. Layers B and C were determined by dividing the sediment column received in a 762-mm (30-in.) sampling tube into two equal sections. Thus, the B and C layers represent the material residing in the first 762 mm (30 in.) of sediment below the surface. In some cases, a second core was obtained by pushing another 762-mm (30-in.) sampling tube into the sediment layer 762 to 1524 mm (30 to 60 in.) below the surface. This tube was then equally divided and designated D and E layers. The iridium concentration gradients defined by layers A-E indicate that 1524 mm (60 in.) was not sufficiently deep to account for all the traced dredge material and that indeed the deeper sediments may have had a higher concentration than the layer E samples. Verification of the higher concentrations in the deeper sediments was



# **LEGEND**

- 139 SAMPLE LOCATION AND HOLE NUMBER
- 08/0c SUBSCRIPT LETTERS B, C, D, AND E
- DENOTE LAYERS

Figure 24. Mare Island profile samples

not possible because the dredge removed more than a 1524-mm (60 in.) depth of material in Mare Island Strait during the September-October dredging operation. As a result, the Mare Island Strait profile data cannot be used to rigorously account for the high traced sediment concentrations detected throughout the test area in the October sampling.

134. In an attempt to determine when and how much traced dredge sediments reentered the Mare Island Strait during the entire testing period, other data were analyzed. Figure 25 shows the data collected for the March-December sampling of holes 1-6 and 63-64. These holes are located in the Mare Island Strait, as shown in Figures 11 and 17. In Figure 25, sample A is for the 0-25.4-mm (0-1-in.) layer of sediment, and each sample from B on is for an additional 101.6 mm (4 in.) of sediment.

135. In the first sampling periods of March, during dredging and tagged sediments introduction, the concentrations of tagged sediments sampled from the Strait and those collected from the dredge's hoppers (Table 12) show a reasonable relationship. After March, the concentrations were lower in an equivalent layer, but a similar concentration can often be seen (Figure 25) in layers of greater depth, suggesting a continuous buildup of sediment above the original heavy influx immediately following dredging.

#### Samples from outside test area

136. Table 13 lists the stations sampled outside of the tracer program test area and the percentage of traced sediments noted at each location. The locations of the sampling stations can be seen in Figure 16. The data indicate some tagged sediments to be in the area adjacent to the cities of Oakland and Alameda. All of the samples were taken in the September-December 1974 period, six months after the original introduction of the tagged sediments but during and after the redredging. Thus, it is not possible to determine the arrival time of the traced material.

#### Conclusions

137. All objectives of the EERL-SRI joint study to identify,

COORDINATES		HOLE NO	LOCATION													
G	H	9	10	1	MARE ISLAND STRAIT											
SAMPLING DATES					14MAR74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)					32.0	34.0	33.0	20.5	30.0	29.5	29.0	27.5	31.0	35.0	33.0	
THICKNESS OF LAYERS (IN)																
FLUFF					0.5	0.5	1.0	5.0	17.0	7.0	4.0	3.0	3.0	6.0	1.0	
ACTIVE					25.0	27.0	20.0	10.0	0.0	20.0	41.0	46.0	13.0	16.0	16.0	
INACTIVE					0.0	0.0	5.0	4.0	0.0	0.0	3.0	0.0	4.0	2.0	4.0	
SAMPLE A					1016	3856	3658	1354	1780	2062	2431	2695	3028	3328	3544	
G DRY/CC WET MUD					0.745	0.549	0.208	0.574	0.446	0.641	0.652	0.478	0.487	0.439	0.558	
G IR/G DRY MUD					1.33E-08	6.50E-10	9.82E-10	5.25E-10	3.65E-10	5.10E-10	6.88E-10	2.54E-10	3.12E-10	6.12E-10	2.88E-10	
1 DREDGE MATERIAL					66.840	1.711	3.415	1.072	0.250	0.995	1.806	0.000	0.000	1.824	0.000	
SAMPLE B					1017	3857	3659	1355	1781	2063	2432	2696	3029	3329	3545	
G DRY/CC WET MUD					0.376	0.494	0.550	0.457	0.425	0.530	0.490	0.471	0.557	0.534	0.490	
G IR/G DRY MUD					9.66E-09	1.58E-09	3.66E-10	4.65E-10	7.05E-10	3.09E-10	2.95E-10	5.14E-11	BDL	3.76E-10	3.71E-10	
1 DREDGE MATERIAL					47.940	6.501	0.254	0.762	1.997	0.000	0.000	0.000	0.000	0.307	0.284	
SAMPLE C					1018	3858	3660	1356	1782	2064	2433	2697	3030	3330	3546	
G DRY/CC WET MUD					0.506	0.556	0.609	0.417	0.498	0.548	0.493	0.541	0.617	0.545	0.480	
G IR/G DRY MUD					9.16E-09	8.32E-10	2.53E-10	7.94E-10	3.20E-10	3.28E-10	9.83E-11	3.72E-10	3.63E-09	8.00E-10	1.08E-10	
1 DREDGE MATERIAL					45.364	2.645	0.000	2.449	0.020	0.059	0.000	0.290	16.986	2.480	0.000	
SAMPLE D					4328	4620										4732
G DRY/CC WET MUD					0.601	0.439										0.647
G IR/G DRY MUD					1.32E-10	1.01E-09										3.58E-10
1 DREDGE MATERIAL					0.000	3.552										0.218
SAMPLE E					1020											
G DRY/CC WET MUD					0.544											
G IR/G DRY MUD					1.86E-08											
1 DREDGE MATERIAL					93.831											
SAMPLE F						4621										
G DRY/CC WET MUD						0.490										
G IR/G DRY MUD						2.05E-09										
1 DREDGE MATERIAL						8.870										
SAMPLE G					4329											
G DRY/CC WET MUD					0.345											
G IR/G DRY MUD					7.66E-10											
1 DREDGE MATERIAL					2.310											
SAMPLE H																
G DRY/CC WET MUD																
G IR/G DRY MUD																
1 DREDGE MATERIAL																

COORDINATES		HOLE NO	LOCATION													
G	E	9	10	2	MARE ISLAND STRAIT											
SAMPLING DATES					15MAR74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)					34.0	31.5	32.0	28.5	27.0	26.5	26.5	27.0	36.5	37.5	36.0	
THICKNESS OF LAYERS (IN)																
FLUFF					0.0	0.0	1.0	7.0	24.0	15.0	4.0	2.0	0.0	7.0	2.0	
ACTIVE					24.0	17.0	20.0	9.0	0.0	12.0	39.0	50.0	29.0	16.0	27.0	
INACTIVE					0.0	0.0	5.0	5.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0	
SAMPLE A					1012	3892	3661	1324	1768	2065	2404	2688	3031	3289	3448	
G DRY/CC WET MUD					0.575	0.412	0.403	0.405	0.477	0.551	0.605	0.460	0.525	0.246	0.435	
G IR/G DRY MUD					2.67E-08	4.78E-11	3.31E-10	2.14E-09	1.29E-09	5.13E-10	5.7E-10	2.67E-10	2.15E-09	6.98E-10	3.89E-10	
1 DREDGE MATERIAL					135.049	0.000	0.079	9.338	4.973	1.013	0.000	0.000	9.400	1.957	0.376	
SAMPLE B					4667	3893	3662	1325	1769	2066	2405	2689	3032	3290	3449	
G DRY/CC WET MUD					0.463	0.406	0.480	0.457	0.371	0.326	0.432	0.447	0.372	0.352	0.349	
G IR/G DRY MUD					4.28E-10	5.85E-10	4.10E-10	1.48E-09	4.80E-10	6.48E-10	3.16E-10	3.02E-10	2.23E-10	4.33E-11	2.33E-10	
1 DREDGE MATERIAL					0.573	1.381	0.482	5.948	0.839	1.704	0.000	0.000	0.000	0.000	0.000	
SAMPLE C					4668	3894	3663	1326	1770	2067	2406	2700	3033	3291	3450	
G DRY/CC WET MUD					0.559	0.457	0.506	0.444	0.449	0.459	0.410	0.395	0.539	0.395	0.498	
G IR/G DRY MUD					2.01E-10	1.43E-09	1.1E-10	9.42E-10	3.15E-10	4.66E-10	3.93E-10	2.38E-10	8.99E-11	4.80E-10	4.04E-10	
1 DREDGE MATERIAL					0.000	5.709	3.052	3.208	0.000	0.767	0.397	0.000	0.000	0.840	0.451	
SAMPLE D					4669	4139										4734
G DRY/CC WET MUD					0.481	0.469										0.350
G IR/G DRY MUD					6.69E-11	1.31E-10										5.00E-10
1 DREDGE MATERIAL					0.000	0.000										0.945
SAMPLE E					4670											4735
G DRY/CC WET MUD					0.674											0.490
G IR/G DRY MUD					1.48E-10											3.43E-10
1 DREDGE MATERIAL					0.000											0.137
SAMPLE F					4671	4140										
G DRY/CC WET MUD					0.569	0.526										
G IR/G DRY MUD					3.56E-10	2.53E-10										
1 DREDGE MATERIAL					0.203	0.000										
SAMPLE G					4672											
G DRY/CC WET MUD					0.540											
G IR/G DRY MUD					2.10E-10											
1 DREDGE MATERIAL					0.000											
SAMPLE H																
G DRY/CC WET MUD																
G IR/G DRY MUD																
1 DREDGE MATERIAL																

Figure 25. Data sheets for holes 1-6 and 63-64, Mare Island Strait (sheet 1 of 4)

COORDINATES	HOLE NO.	LOCATION										
G A 9 10	3	MARE ISLAND STRAIT										
SAMPLING DATES	6MART74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	24.0	31.0	31.0	33.0	31.5	30.0	29.5	29.0	36.5	36.5	37.5	
THICKNESS OF LAYERS (IN)												
FLUFF	0.0	0.0	1.0	7.5	0.0	3.0	2.0	2.0	2.0	4.0	1.0	
ACTIVE	18.0	15.0	12.0	5.0	21.0	22.0	45.0	51.0	22.0	19.0	19.0	
INACTIVE	0.0	0.0	5.0	7.0	0.0	0.0	0.0	0.0	4.0	4.0	5.0	
SAMPLE A	3898	3859	3676	1330	1762	2068	2440	2701	3055	3292	3361	
G DRY/CC WET MUD	0.697	0.376	0.660	0.554	0.569	0.422	0.518	0.509	0.396	0.458	0.361	
G IR/G DRY MUD	-BDL-	7.74E-10	-BDL-	3.12E-10	1.02E-09	2.88E-10	4.81E-10	2.63E-10	-BDL-	7.59E-10	1.90E-10	
Σ DREDGE MATERIAL	0.000	2.347	0.000	0.000	3.633	0.000	0.844	0.000	0.000	2.270	0.000	
SAMPLE B	3899	3860	3677	1331	1763	2069	2441	2702	3056	3293	3362	
G DRY/CC WET MUD	0.540	0.499	0.499	0.462	0.444	0.531	0.527	0.509	0.543	0.488	0.424	
G IR/G DRY MUD	2.80E-10	3.48E-09	1.58E-09	2.84E-10	3.57E-10	3.39E-10	1.20E-10	2.51E-10	7.46E-10	3.88E-10	3.71E-10	
Σ DREDGE MATERIAL	0.000	16.244	6.478	0.000	0.211	0.117	0.000	0.000	2.204	0.371	0.285	
SAMPLE C	3900	3861	3678	1332	1764	2070	2442	2703	3057	3294	3363	
G DRY/CC WET MUD	0.588	0.428	0.608	0.529	0.546	0.491	0.556	0.590	0.543	0.611	0.475	
G IR/G DRY MUD	-BDL-	3.05E-11	4.96E-10	4.56E-10	2.17E-10	4.73E-10	3.03E-10	3.40E-10	1.00E-09	1.51E-10	4.16E-10	
Σ DREDGE MATERIAL	0.000	0.000	0.925	0.721	0.000	0.805	0.000	0.122	3.515	0.000	0.512	
SAMPLE D	4141	4143										
G DRY/CC WET MUD	0.573	0.707										
G IR/G DRY MUD	1.74E-10	1.28E-10										
Σ DREDGE MATERIAL	0.000	0.000										
SAMPLE E												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE F	4142											
G DRY/CC WET MUD	0.618											
G IR/G DRY MUD	1.51E-11											
Σ DREDGE MATERIAL	0.000											
SAMPLE G		4144										
G DRY/CC WET MUD		0.631										
G IR/G DRY MUD		4.30E-09										
Σ DREDGE MATERIAL		20.442										
SAMPLE H												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES	HOLE NO.	LOCATION										
F H 9 10	4	MARE ISLAND STRAIT										
SAMPLING DATES	14MART74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	30.0	30.0	29.0	32.0	31.0	29.5	29.0	28.5	31.5	35.5	32.0	
THICKNESS OF LAYERS (IN)												
FLUFF	6.5	-NA-	2.0	9.0	0.0	2.0	2.5	3.0	1.0	1.0	2.0	
ACTIVE	14.0	-NA-	15.0	16.0	21.0	20.0	49.0	22.0	23.0	23.0	24.0	
INACTIVE	0.0	-NA-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
SAMPLE A	1042	3835	3703	1321	1765	2083	2437	2704	3010	3295	3412	
G DRY/CC WET MUD	0.348	0.512	0.680	0.336	0.467	0.378	0.612	0.425	0.469	0.496	0.532	
G IR/G DRY MUD	9.87E-09	3.42E-10	1.72E-09	4.56E-10	2.72E-10	3.25E-10	4.14E-10	-BDL-	4.82E-10	2.71E-10	1.79E-10	
Σ DREDGE MATERIAL	48.973	0.135	7.203	0.718	0.000	0.047	0.505	0.000	0.851	0.000	0.000	
SAMPLE B	1044	3836	3704	1322	1766	2084	2438	2705	3011	3296	3413	
G DRY/CC WET MUD	0.364	0.750	0.582	0.440	0.395	0.708	0.527	0.503	0.597	0.482	0.671	
G IR/G DRY MUD	7.73E-09	1.20E-09	8.20E-10	7.48E-10	3.84E-10	1.16E-09	4.38E-10	5.29E-10	3.33E-10	-BDL-	2.32E-10	
Σ DREDGE MATERIAL	38.011	4.520	2.584	2.218	0.348	4.343	0.623	1.091	0.086	0.000	0.000	
SAMPLE C	1043	3837	3705	1323	1767	2085	2439	2706	3012	3297	3414	
G DRY/CC WET MUD	0.665	0.510	0.656	0.447	0.431	0.596	0.558	0.499	0.568	0.584	0.671	
G IR/G DRY MUD	4.32E-09	6.73E-09	1.30E-09	9.68E-10	3.08E-10	6.13E-10	9.47E-11	1.85E-10	4.99E-10	2.81E-10	4.13E-10	
Σ DREDGE MATERIAL	20.537	32.911	5.040	3.343	0.000	1.522	0.000	0.000	0.937	0.000	0.500	
SAMPLE D	4332	4145										
G DRY/CC WET MUD	0.635	0.544										
G IR/G DRY MUD	2.63E-10	6.45E-11										
Σ DREDGE MATERIAL	0.000	0.000										
SAMPLE E												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE F	4333											
G DRY/CC WET MUD	0.583											
G IR/G DRY MUD	4.88E-10											
Σ DREDGE MATERIAL	0.884											
SAMPLE G												
G DRY/CC WET MUD												
G IR/G DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H		4146										
G DRY/CC WET MUD		0.713										
G IR/G DRY MUD		3.91E-10										
Σ DREDGE MATERIAL		0.383										

Figure 25 (sheet 2 of 4)

COORDINATES	HOLE NO.	LOCATION										
F E 9 10	5	MARE ISLAND STRAIT										
SAMPLING DATES	8MAR74	27MAR74	15APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	24.6	35.0	35.0	34.0	35.5	35.5	35.0	35.0	38.0	37.5	37.5	
THICKNESS OF LAYERS (IN)												
FLUFF	0.0	0.5	1.5	6.0	9.0	1.0	1.0	2.0	5.0	2.0	0.0	
ACTIVE	18.0	17.0	8.0	9.0	13.0	9.0	22.0	14.0	18.0	17.0	2.0	
INACTIVE	0.0	5.0	8.0	5.0	0.0	5.0	0.0	5.0	4.0	10.0	19.0	
SAMPLE A	1096	3790	1117	1342	1783	2071	2407	2707	3034	3349	3442	
G DRY/CC WET MUD	0.415	0.279	0.323	0.861	0.526	0.595	0.679	0.582	0.517	0.438	0.501	
G IR/G DRY MUD	1.78E-09	5.1E-10	6.8E-09	2.7E-10	8.0E-10	9.0E-10	2.10E-10	3.26E-10	1.16E-10	8.8E-10	7.7E-10	
I DREDGE MATERIAL	7.492	0.692	7.001	1.085	0.000	0.000	0.000	0.051	0.000	0.000	2.364	
SAMPLE B	1098	3791	1118	1343	1784	2072	2408	2708	3035	3350	3443	
G DRY/CC WET MUD	0.542	0.465	0.564	0.569	0.453	0.498	0.588	0.548	0.547	0.531	0.517	
G IR/G DRY MUD	2.24E-09	6.99E-10	1.72E-09	1.02E-09	4.18E-10	3.17E-10	4.46E-12	4.10E-10	5.73E-10	2.07E-11	3.07E-10	
I DREDGE MATERIAL	9.852	1.963	7.184	3.625	0.524	0.005	0.000	0.484	1.319	0.000	0.000	
SAMPLE C	1097	3792	1119	1344	1785	2073	2409	2709	3036	3351	3444	
G DRY/CC WET MUD	0.538	0.493	0.582	0.543	0.547	0.656	0.580	0.595	0.573	0.625	0.521	
G IR/G DRY MUD	3.43E-09	1.60E-09	1.00E-09	3.58E-10	5.42E-10	BDL	4.77E-10	4.76E-10	3.04E-10	7.15E-11	6.03E-10	
I DREDGE MATERIAL	15.947	6.586	3.520	0.215	1.160	0.000	0.825	0.818	0.000	0.000	1.472	
SAMPLE D	4514	4147										
G DRY/CC WET MUD	0.586	0.527										
G IR/G DRY MUD	1.12E-09	1.04E-10										
I DREDGE MATERIAL	4.109	0.000										
SAMPLE E		4148										
G DRY/CC WET MUD		0.532										
G IR/G DRY MUD		5.65E-11										
I DREDGE MATERIAL		0.000										
SAMPLE F												
G DRY/CC WET MUD												
G IR/G DRY MUD												
I DREDGE MATERIAL												
SAMPLE G	4515											
G DRY/CC WET MUD	0.636											
G IR/G DRY MUD	9.98E-11											
I DREDGE MATERIAL	0.000											
SAMPLE H												
G DRY/CC WET MUD												
G IR/G DRY MUD												
I DREDGE MATERIAL												
COORDINATES	HOLE NO.	LOCATION										
F B 9 10	6	MARE ISLAND STRAIT										
SAMPLING DATES	8MAR74	27MAR74	15APR74	7MAY74	14JUN74	25JUL74	16AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	28.0	37.0	32.0	29.3	33.0	35.0	36.0	32.0	33.5	41.5	34.5	
THICKNESS OF LAYERS (IN)												
FLUFF	0.5	0.5	2.5	3.0	4.5	2.0	2.0	0.0	5.0	0.0	0.0	
ACTIVE	15.0	17.0	11.0	9.0	10.0	25.0	6.0	9.0	11.0	20.0	3.0	
INACTIVE	0.0	0.0	12.0	4.0	8.0	0.0	12.0	9.0	9.0	5.0	21.0	
SAMPLE A	1081	3862	1165	1327	1774	2086	2395	2710	3037	3235	3358	
G DRY/CC WET MUD	0.560	0.365	0.497	0.674	0.662	0.446	0.616	0.648	0.603	0.527	0.426	
G IR/G DRY MUD	2.87E-09	5.94E-11	9.95E-10	7.97E-10	7.30E-10	4.46E-10	7.29E-10	6.10E-10	6.25E-10	6.65E-10	1.66E-10	
I DREDGE MATERIAL	13.094	0.000	3.484	2.469	2.122	0.666	2.119	1.507	1.586	1.790	0.000	
SAMPLE B	1083	3863	1166	1328	1775	2087	2396	2711	3038	3236	3359	
G DRY/CC WET MUD	0.750	0.413	0.646	LOST	0.647	0.495	0.596	0.583	0.565	0.774	0.593	
G IR/G DRY MUD	3.12E-09	8.18E-10	2.11E-09	SAMPLE 4	5.3E-10	6.51E-10	2.64E-10	3.86E-10	4.94E-10	6.15E-11	3.41E-10	
I DREDGE MATERIAL	14.399	2.576	9.220		0.705	1.717	0.000	0.360	0.914	0.000	0.127	
SAMPLE C	1082	3864	1167	1329	1776	2088	2397	2712	3039	3237	3360	
G DRY/CC WET MUD	0.612	0.620	0.628	0.551	0.587	0.625	0.604	0.529	0.656	0.724	0.552	
G IR/G DRY MUD	1.15E-09	BDL	9.54E-10	2.66E-10	6.18E-10	5.18E-10	9.00E-11	4.05E-10	5.41E-10	3.92E-11	3.67E-10	
I DREDGE MATERIAL	4.297	0.000	3.273	0.000	1.551	1.037	0.000	0.455	1.157	0.000	0.262	
SAMPLE D	4149											
G DRY/CC WET MUD	0.600											
G IR/G DRY MUD	5.74E-10											
I DREDGE MATERIAL	1.323											
SAMPLE E												
G DRY/CC WET MUD												
G IR/G DRY MUD												
I DREDGE MATERIAL												
SAMPLE F												
G DRY/CC WET MUD												
G IR/G DRY MUD												
I DREDGE MATERIAL												
SAMPLE G	4150											
G DRY/CC WET MUD	0.650											
G IR/G DRY MUD	1.52E-10											
I DREDGE MATERIAL	0.000											
SAMPLE H												
G DRY/CC WET MUD												
G IR/G DRY MUD												
I DREDGE MATERIAL												

Figure 25 (sheet 3 of 4)

COORDINATES	HOLE	LOCATION								
H C 9 9	NO 63	MARE ISLAND STRAIT								
SAMPLING DATES	22APR74	7MAY74	14JUN74	25JUL74	21AUG74	16SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	22.0	21.0	20.0	18.5	20.5	21.0	23.0	22.5	20.5	
THICKNESS OF LAYERS (IN)										
FLUFF	2.0	1.5	2.5	1.0	1.0	1.0	1.0	0.0	0.0	
ACTIVE	6.0	8.0	7.0	8.0	11.0	10.0	11.0	6.0	4.0	
INACTIVE	6.0	8.0	6.0	6.0	8.0	4.0	7.0	14.0	14.0	
SAMPLE A	1267	1345	1759	2077	2443	2689	3058	3298	3502	
G DRY/CC WET MUD	0.611	0.711	0.606	0.674	0.599	0.529	0.486	0.592	0.678	
G IR/G DRY MUD	5.82E-10	7.54E-10	5.27E-10	5.56E-09	2.13E-10	-BDL-	1.71E-10	2.48E-10	1.52E-10	
Σ DREDGE MATERIAL	1.364	2.249	1.081	26.914	0.000	0.000	0.000	0.000	0.000	
SAMPLE B	1268	1346	1760	2078	2444	2690	3059	3299	3503	
G DRY/CC WET MUD	0.528	0.588	0.593	0.492	0.575	0.574	0.567	0.574	0.563	
G IR/G DRY MUD	4.78E-10	4.83E-10	6.61E-10	2.23E-09	1.07E-09	3.21E-10	3.16E-10	8.52E-11	1.01E-09	
Σ DREDGE MATERIAL	0.833	0.856	1.768	9.829	3.870	0.026	0.002	0.000	3.571	
SAMPLE C	1269	1347	1761	2079	2445	2691	3060	3300	3504	
G DRY/CC WET MUD	0.554	0.579	0.592	0.598	0.563	0.563	0.607	0.668	0.426	
G IR/G DRY MUD	1.99E-10	4.79E-10	1.52E-10	3.04E-09	7.74E-11	1.54E-10	1.13E-09	2.61E-10	5.31E-10	
Σ DREDGE MATERIAL	0.000	0.834	0.000	13.968	0.000	0.000	4.167	0.000	1.105	
SAMPLE D								4785		
G DRY/CC WET MUD								0.638		
G IR/G DRY MUD								3.01E-11		
Σ DREDGE MATERIAL								0.000		
SAMPLE E								4786		
G DRY/CC WET MUD								0.571		
G IR/G DRY MUD								1.94E-10		
Σ DREDGE MATERIAL								0.000		
SAMPLE F										
G DRY/CC WET MUD										
G IR/G DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE G										
G DRY/CC WET MUD										
G IR/G DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G DRY/CC WET MUD										
G IR/G DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES	HOLE	LOCATION								
H H 9 10	NO 64	MARE ISLAND STRAIT								
SAMPLING DATES	22APR74	7MAY74	14JUN74	23JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	25.5	25.5	26.5	23.0	22.5	23.0	28.0	25.5	26.5	
THICKNESS OF LAYERS (IN)										
FLUFF	1.0	1.5	2.0	0.0	0.0	0.0	1.0	0.0	0.0	
ACTIVE	10.0	4.0	7.0	5.0	6.0	6.0	5.0	4.0	2.0	
INACTIVE	14.0	11.0	8.0	12.0	10.0	14.0	10.0	21.0	21.0	
SAMPLE A	1228	1357	1771	1999	2434	2713	3040	3304	3505	
G DRY/CC WET MUD	0.348	0.580	0.630	0.690	0.763	0.465	0.594	0.515	0.694	
G IR/G DRY MUD	5.17E-09	6.77E-10	4.00E-10	3.60E-10	3.06E-10	-BDL-	-BDL-	4.91E-10	8.12E-11	
Σ DREDGE MATERIAL	24.872	1.854	0.429	0.224	0.000	0.000	0.000	0.900	0.000	
SAMPLE B	1229	1358	1772	2000	2435	2714	3041	3305	3506	
G DRY/CC WET MUD	0.566	0.543	0.586	0.524	0.610	0.567	0.585	0.599	0.660	
G IR/G DRY MUD	5.39E-09	7.74E-10	5.30E-10	1.84E-10	4.32E-10	4.23E-10	8.45E-11	2.91E-10	1.58E-10	
Σ DREDGE MATERIAL	25.954	2.350	1.098	0.000	0.593	0.548	0.000	0.000	0.000	
SAMPLE C	1230	1359	1773	2001	2436	2715	3042	3306	3507	
G DRY/CC WET MUD	0.604	0.580	0.567	0.535	0.626	0.604	0.671	0.594	0.520	
G IR/G DRY MUD	1.52E-09	7.73E-10	5.44E-10	2.21E-10	3.18E-11	3.93E-10	4.19E-10	2.57E-10	2.48E-10	
Σ DREDGE MATERIAL	6.182	2.343	1.170	0.000	0.000	0.395	0.528	0.000	0.000	
SAMPLE D								4787		
G DRY/CC WET MUD								0.595		
G IR/G DRY MUD								-BDL-		
Σ DREDGE MATERIAL								0.000		
SAMPLE E										
G DRY/CC WET MUD										
G IR/G DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE F								4788		
G DRY/CC WET MUD								0.585		
G IR/G DRY MUD								1.60E-09		
Σ DREDGE MATERIAL								6.563		
SAMPLE G										
G DRY/CC WET MUD										
G IR/G DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G DRY/CC WET MUD										
G IR/G DRY MUD										
Σ DREDGE MATERIAL										

Figure 25 (sheet 4 of 4)

Table 13  
Samples from Outside Test Area

<u>Location</u>	<u>Depth*</u>	<u>Date</u>	<u>Percent IR in Dredge Material</u>	<u>Grams Dry/cc Wet Mud</u>
H142	A	092474	0	1.222E+00
H142	B	092474	0	9.266E-01
H142	C	092474	0.670	9.249E-01
H142	D	092474	0	7.902E-01
H143	A	092474	3.517	6.071E-01
H143	B	092474	1.717	5.506E-01
H143	C	092474	0	4.328E-01
H144	A	092474	0.381	4.821E-01
H144	B	092474	0	3.983E-01
H144	C	092474	0	5.123E-01
H145	A	092774	0	6.139E-01
H145	B	092774	0	3.635E-01
H145	C	092774	0	4.427E-01
H146	A	092774	0.693	6.694E-01
H146	B	092774	1.240	3.639E-01
H146	C	092774	4.380	5.425E-01
H146	D	092774	0.569	5.412E-01
H146	G	092774	0	5.102E-01
H147	A	102974	2.525	1.383E+00
H147	B	102974	0.973	6.427E-01
H148	A	102974	0	7.533E-01
H148	B	102974	0	4.805E-01
H148	C	102974	0	4.143E-01
H149	A	103074	1.097	6.897E-01
H149	B	103074	0	9.438E-01
H149	C	103074	0	9.442E-01
H150	A	103074	0	8.063E-01
H150	B	103074	0	5.924E-01
H150	C	103074	0	5.145E-01

(Continued)

- \* A = 0-25.4 mm (0-1 in.).  
 B = 25.4-127 mm (1-5 in.).  
 C = 127-229 mm (5-9 in.).  
 D = 229-330 mm (9-13 in.).  
 G = 533-635 mm (21-25 in.).

Table 13 (Concluded)

<u>Location</u>	<u>Depth</u>	<u>Date</u>	<u>Percent IR in Dredge Material</u>	<u>Grams Dry/cc Wet Mud</u>
H151	A	103174	0	8.628E-01
H151	B	103174	0	7.373E-01
H151	C	103174	0.371	7.864E-01
H152	A	112674	0	6.735E-01
H152	B	112674	0	6.818E-01
H152	C	112674	0	6.978E-01
H153	A	112674	0	1.296E+00
H153	B	112674	0	1.605E+00
H153	C	112674	0	1.563E+00
H154	A	112674	0	5.678E-01
H154	B	112674	0.057	5.300E-01
H154	C	112674	2.411	6.973E-01
H154	D	112674	0.402	8.530E-01
H155	A	112674	0	6.711E-01
H155	B	112674	0	7.330E-01
H155	C	112674	0	6.685E-01
H156	A	112674	0	5.647E-01
H156	B	112674	0	8.604E-01
H156	C	112674	0	9.253E-01
H157	A	121974	0	8.521E-01
H157	B	121974	0	8.126E-01
H157	C	121974	0	7.950E-01
H158	A	121974	0	6.601E-01
H158	B	121974	0	4.938E-01
H158	C	121974	0	3.669E-01
H159	A	121974	0	7.351E-01
H159	B	121974	0	6.440E-01
H159	C	121974	0	7.180E-01
H160	A	121974	0.013	8.579E-01
H160	B	121974	0	8.913E-01
H160	C	121974	0.179	5.829E-01
H161	A	121974	0	9.161E-01
H161	B	121974	0	7.623E-01
H161	C	121974	0	8.569E-01

develop, and demonstrate a suitable tracer for following the movement of dredged sediment in the San Francisco Bay were successfully accomplished.

138. Iridium was found to be the most cost-effective chemical element for tagging and tracing sediments in the San Francisco Bay. Although iridium would probably be effective in most areas because of its low natural abundance and neutronic properties, other chemical elements may be more cost-effective for tracing dredged sediments in other locations.

139. The sediment-tagging procedure yielded a workable and practical tracer that was capable of identifying dredged sediment concentrations as low as one percent.

140. From the Mare Island Strait, 2,000,000 yd<sup>3</sup> of dredged sediments were tagged with iridium. Approximately 4,000 samples were collected and analyzed over a period of almost a year. The data will be used to define the deposition, dispersion, and long-term circulation patterns of sediments dredged from the Mare Island Strait.

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INCLOSURE 2

Tracer Program Sample Analysis Data

Test Area Samples	1
Hopper Samples	113
Central and South Bay Samples	116
Mare Island Strait Profiles	119

COORDINATES		HOLE NO.	LOCATION									
G	H	9	10	1 MARE ISLAND STRAIT								
SAMPLING DATES		14MAR74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		32.0	34.0	33.0	20.5	30.0	29.5	29.0	27.5	31.0	35.0	33.0
THICKNESS OF LAYERS (IN)												
FLUFF		0.5	0.5	1.0	5.0	17.0	7.0	4.0	3.0	3.0	6.0	1.0
ACTIVE		25.0	27.0	20.0	10.0	0.0	20.0	41.0	46.0	13.0	16.0	16.0
INACTIVE		0.0	0.0	5.0	4.0	0.0	0.0	3.0	0.0	4.0	2.0	4.0
SAMPLE A		1016	3856	3658	1354	1780	2062	2431	2695	3028	3328	3544
G. DRY/CC. WET MUD		0.745	0.549	0.208	0.574	0.446	0.641	0.652	0.478	0.487	0.439	0.558
G. IR/G. DRY MUD		1.33E-08	6.50E-10	9.82E-10	3.65E-10	5.10E-10	6.68E-10	2.54E-10	3.12E-10	6.72E-10	2.86E-10	1.0
Σ DREDGE MATERIAL		66.840	1.711	3.415	1.072	0.250	0.995	1.806	0.000	0.000	1.824	0.000
SAMPLE B		1017	3857	3659	1355	1781	2063	2432	2696	3029	3329	3545
G. DRY/CC. WET MUD		0.376	0.494	0.550	0.457	0.425	0.530	0.490	0.471	0.557	0.534	0.490
G. IR/G. DRY MUD		9.66E-09	1.58E-09	3.66E-10	4.65E-10	7.05E-10	3.09E-10	2.93E-10	5.14E-11	-80L	3.76E-10	3.71E-10
Σ DREDGE MATERIAL		47.940	6.501	0.254	0.762	1.997	0.000	0.000	0.000	0.000	0.307	0.284
SAMPLE C		1018	3858	3660	1356	1782	2064	2433	2697	3030	4733	3546
G. DRY/CC. WET MUD		0.506	0.556	0.609	0.417	0.498	0.548	0.493	0.541	0.617	0.545	0.580
G. IR/G. DRY MUD		9.16E-09	8.32E-10	2.53E-10	7.94E-10	3.20E-10	3.26E-10	9.83E-11	3.72E-10	3.63E-09	8.00E-10	1.08E-10
Σ DREDGE MATERIAL		45.364	2.645	0.000	2.449	0.020	0.059	0.000	0.290	16.986	2.480	0.000
SAMPLE D		4328	4620								4732	
G. DRY/CC. WET MUD		0.601	0.439								0.647	
G. IR/G. DRY MUD		1.32E-10	1.01E-09								3.58E-10	
Σ DREDGE MATERIAL		0.000	3.552								0.218	
SAMPLE E		1020										
G. DRY/CC. WET MUD		0.544										
G. IR/G. DRY MUD		1.86E-08										
Σ DREDGE MATERIAL		93.831										
SAMPLE F			4621									
G. DRY/CC. WET MUD			0.490									
G. IR/G. DRY MUD			2.05E-09									
Σ DREDGE MATERIAL			8.870									
SAMPLE G		4329										
G. DRY/CC. WET MUD		0.345										
G. IR/G. DRY MUD		7.66E-10										
Σ DREDGE MATERIAL		2.310										
SAMPLE H												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION									
G E 9 10		2	MARE ISLAND STRAIT									
SAMPLING DATES		15MAR74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		34.0	31.5	32.0	28.5	27.0	26.5	26.5	27.0	36.5	37.5	36.0
THICKNESS OF LAYERS (IN)												
FLUFF		0.0	0.0	1.0	7.0	24.0	15.0	4.0	2.0	0.0	7.0	2.0
ACTIVE		24.0	17.0	20.0	9.0	0.0	12.0	39.0	50.0	29.0	16.0	27.0
INACTIVE		0.0	0.0	5.0	5.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0
SAMPLE A		1012	3892	3661	1324	1768	2065	2404	2598	3031	3289	3448
G.DRY/CC.WET MUD		0.575	0.412	0.403	0.405	0.477	0.551	0.605	0.460	0.525	0.246	0.435
G.IR/G.DRY MUD		2.67E-08	4.78E-11	3.31E-10	2.14E-09	1.29E-09	5.13E-10	1.57E-10	2.87E-10	2.15E-09	6.98E-10	3.89E-10
* DREDGE MATERIAL		135.049	0.000	0.079	9.338	4.973	1.013	0.000	0.000	9.400	1.957	0.376
SAMPLE B		4667	3893	3662	1325	1769	2066	2405	2599	3032	3290	3449
G.DRY/CC.WET MUD		0.463	0.406	0.488	0.457	0.371	0.326	0.432	0.447	0.372	0.352	0.349
G.IR/G.DRY MUD		4.28E-10	5.95E-10	4.10E-10	1.48E-09	4.80E-10	6.48E-10	3.16E-10	3.02E-10	2.23E-10	9.33E-11	2.33E-10
* DREDGE MATERIAL		0.573	1.381	0.482	5.948	0.839	1.704	0.000	0.000	0.000	0.000	0.000
SAMPLE C		4668	3894	3663	1326	1770	2067	2406	2700	3033	3291	3450
G.DRY/CC.WET MUD		0.559	0.457	0.506	0.444	0.449	0.459	0.410	0.395	0.539	0.395	0.398
G.IR/G.DRY MUD		2.01E-10	1.43E-09	9.11E-10	9.42E-10	3.15E-10	4.66E-10	3.93E-10	2.38E-10	8.99E-11	4.80E-10	4.04E-10
* DREDGE MATERIAL		0.000	5.709	3.052	3.208	0.000	0.767	0.397	0.000	0.000	0.840	0.451
SAMPLE D		4669	4139								4734	
G.DRY/CC.WET MUD		0.481	0.469								0.350	
G.IR/G.DRY MUD		6.69E-11	1.31E-10								5.00E-10	
* DREDGE MATERIAL		0.000	0.000								0.945	
SAMPLE E		4670									4735	
G.DRY/CC.WET MUD		0.674									0.490	
G.IR/G.DRY MUD		1.48E-10									3.43E-10	
* DREDGE MATERIAL		0.000									0.137	
SAMPLE F		4671	4140									
G.DRY/CC.WET MUD		0.569	0.526									
G.IR/G.DRY MUD		3.56E-10	2.53E-10									
* DREDGE MATERIAL		0.203	0.000									
SAMPLE G		4672										
G.DRY/CC.WET MUD		0.540										
G.IR/G.DRY MUD		2.10E-10										
* DREDGE MATERIAL		0.000										
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION									
G A 9 10	3		MARE ISLAND STRAIT									
SAMPLING DATES		5MAR74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		24.0	31.0	31.0	33.0	31.5	30.0	29.5	29.0	36.5	36.5	37.5
THICKNESS OF LAYERS (IN)												
FLUFF												
ACTIVE												
INACTIVE												
SAMPLE A												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE B												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE C												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE D												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE E												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE F												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE G												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE H												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION										
F	H	9	10	4									
MARE ISLAND STRAIT													
SAMPLING DATES		14MAR74	27MAR74	9APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		30.0	30.0	29.0	32.0	31.0	29.5	29.0	28.5	31.5	35.5	32.0	
THICKNESS OF LAYERS (IN)													
FLUFF		6.5	-NA-	2.0	9.0	0.0	2.0	2.5	3.0	1.0	1.0	2.0	
ACTIVE		14.0	-NA-	15.0	16.0	21.0	20.0	49.0	22.0	23.0	23.0	24.0	
INACTIVE		0.0	-NA-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
SAMPLE A		1042	3835	3703	1321	1765	2083	2437	2704	3010	3295	3412	
G. DRY/CC. WET MUD		0.348	0.512	0.680	0.336	0.467	0.378	0.612	0.425	0.469	0.496	0.532	
G. IR/G. DRY MUD		9.87E-09	3.42E-10	1.72E-09	4.56E-10	2.72E-10	3.25E-10	4.14E-10	-80L-	4.82E-10	2.71E-10	1.79E-10	
Σ DREDGE MATERIAL		48.973	0.135	7.203	0.718	0.000	0.047	0.505	0.000	0.851	0.000	0.000	
SAMPLE B		1044	3836	3704	1322	1765	2084	2438	2705	3011	3296	3413	
G. DRY/CC. WET MUD		0.364	0.750	0.582	0.440	0.395	0.708	0.527	0.503	0.597	0.482	0.671	
G. IR/G. DRY MUD		7.73E-09	1.20E-09	8.20E-10	7.48E-10	3.84E-10	1.16E-09	4.38E-10	5.29E-10	3.33E-10	-80L-	2.32E-10	
Σ DREDGE MATERIAL		38.011	4.520	2.584	2.218	0.348	4.343	0.623	1.091	0.086	0.000	0.000	
SAMPLE C		1043	3837	3705	1323	1767	2085	2439	2706	3012	3297	3414	
G. DRY/CC. WET MUD		0.665	0.510	0.656	0.447	0.431	0.596	0.568	0.499	0.568	0.584	0.671	
G. IR/G. DRY MUD		4.32E-09	6.73E-09	1.30E-09	9.68E-10	3.08E-10	6.13E-10	9.47E-11	1.85E-10	4.99E-10	2.81E-10	4.13E-10	
Σ DREDGE MATERIAL		20.537	32.911	5.040	3.343	0.000	1.522	0.000	0.000	0.937	0.000	0.500	
SAMPLE D		4332	4145										4738
G. DRY/CC. WET MUD		0.635	0.544										0.521
G. IR/G. DRY MUD		2.63E-10	6.45E-11										8.78E-10
Σ DREDGE MATERIAL		0.000	0.000										2.881
SAMPLE E													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE F		4333										4739	
G. DRY/CC. WET MUD		0.583										0.539	
G. IR/G. DRY MUD		4.88E-10										5.07E-10	
Σ DREDGE MATERIAL		0.884										0.980	
SAMPLE G													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE H		4146										4738	
G. DRY/CC. WET MUD		0.713										0.521	
G. IR/G. DRY MUD		3.91E-10										8.78E-10	
Σ DREDGE MATERIAL		0.383										2.881	

COORDINATES		HOLE LOCATION															
F	E	9	10	NO.	5	MARE ISLAND STRAIT											
SAMPLING DATES		8MAR74	27MAR74	15APR74	7MAY74	14JUN74	25JUL74	21AUG74	18SEP74	18OCT74	21NOV74	5OEC74					
DEPTH OF SEDIMENT BELOW MLLW (FT)		24.6	35.0	35.0	34.0	35.5	35.5	35.0	35.0	38.0	37.5	37.5					
THICKNESS OF LAYERS (IN)																	
FLUFF		0.0	0.5	1.5	6.0	9.0	1.0	1.0	2.0	5.0	2.0	0.0					
ACTIVE		18.0	17.0	8.0	9.0	13.0	9.0	22.0	14.0	18.0	17.0	2.0					
INACTIVE		0.0	5.0	8.0	5.0	0.0	5.0	0.0	5.0	4.0	10.0	19.0					
SAMPLE A		1096	3790	1117	1342	1783	2071	2407	2707	3034	3349	3442					
G. DRY/CC. WET MUD		0.415	0.279	0.323	0.861	0.526	0.595	0.679	0.582	0.517	0.438	0.501					
G. IR/G. DRY MUD		1.78E-09	4.51E-10	1.68E-09	5.27E-10	2.80E-10	1.90E-10	2.10E-10	3.26E-10	1.16E-10	1.88E-10	7.77E-10					
DREDGE MATERIAL		7.492	0.692	7.001	1.085	0.000	0.000	0.000	0.051	0.000	0.000	2.364					
SAMPLE B		1098	3791	1118	1343	1784	2072	2408	2708	3035	3350	3443					
G. DRY/CC. WET MUD		0.542	0.465	0.564	0.569	0.453	0.498	0.588	0.548	0.547	0.531	0.517					
G. IR/G. DRY MUD		2.24E-09	6.99E-10	1.72E-09	1.02E-09	4.18E-10	3.17E-10	4.46E-12	4.10E-10	5.73E-10	2.07E-11	3.07E-10					
DREDGE MATERIAL		9.852	1.963	7.184	3.625	0.524	0.005	0.000	0.484	1.319	0.000	0.000					
SAMPLE C		1097	3792	1119	1344	1785	2073	2409	2709	3036	3351	3444					
G. DRY/CC. WET MUD		0.538	0.493	0.562	0.543	0.547	0.656	0.580	0.595	0.573	0.625	0.521					
G. IR/G. DRY MUD		3.43E-09	1.60E-09	1.00E-09	3.58E-10	5.42E-10	-80L-	4.77E-10	4.76E-10	3.04E-10	7.16E-11	6.03E-10					
DREDGE MATERIAL		15.947	6.586	3.520	0.215	1.160	0.000	0.825	0.818	0.000	0.000	1.472					
SAMPLE D		4514	4147								4740						
G. DRY/CC. WET MUD		0.586	0.527								0.565						
G. IR/G. DRY MUD		1.12E-09	1.04E-10								-80L-						
DREDGE MATERIAL		4.109	0.000								0.000						
SAMPLE E			4148														
G. DRY/CC. WET MUD			0.532														
G. IR/G. DRY MUD			5.65E-11														
DREDGE MATERIAL			0.000														
SAMPLE F																	
G. DRY/CC. WET MUD																	
G. IR/G. DRY MUD																	
DREDGE MATERIAL																	
SAMPLE G		4515															
G. DRY/CC. WET MUD		0.635															
G. IR/G. DRY MUD		9.98E-11															
DREDGE MATERIAL		0.000															
SAMPLE H																	
G. DRY/CC. WET MUD																	
G. IR/G. DRY MUD																	
DREDGE MATERIAL																	

COORDINATES		HOLE NO.	LOCATION											
F B 9 10		6	MARE ISLAND STRAIT											
SAMPLING DATES		8MAR74	27MAR74	15APR74	7MAY74	14JUN74	25JUL74	16AUG74	18SEP74	18OCT74	21NOV74	50EC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		28.0	37.0	32.0	29.3	33.0	35.0	36.0	32.0	33.5	41.5	34.5		
THICKNESS OF LAYERS (IN)		0.5	0.5	2.5	3.0	4.5	2.0	2.0	0.0	5.0	0.0	0.0		
FLUFF		15.0	17.0	11.0	9.0	10.0	25.0	6.0	9.0	11.0	20.0	3.0		
ACTIVE		0.0	0.0	12.0	4.0	8.0	0.0	12.0	9.0	9.0	5.0	21.0		
INACTIVE														
SAMPLE A		1081	3862	1165	1327	1774	2086	2395	2710	3037	3235	3358		
G.DRY/CC.WET MUD		0.560	0.365	0.497	0.674	0.662	0.446	0.616	0.648	0.603	0.527	0.426		
G.IR/G.DRY MUD		2.87E-09	5.94E-11	9.95E-10	7.97E-10	7.30E-10	4.46E-10	7.29E-10	6.10E-10	6.25E-10	6.65E-10	1.66E-10		
* DREDGE MATERIAL		13.034	0.000	3.484	2.469	2.122	0.666	2.119	1.507	1.586	1.790	0.000		
SAMPLE B		1083	3863	1166	1775	2087	2396	2711	3038	3236	3359			
G.DRY/CC.WET MUD		0.750	0.413	0.646	LOST	0.647	0.495	0.596	0.583	0.565	0.774	0.593		
G.IR/G.DRY MUD		3.12E-09	8.18E-10	2.11E-09	SAMPLE	4.53E-10	6.51E-10	2.64E-10	3.86E-10	4.94E-10	6.15E-11	3.41E-10		
* DREDGE MATERIAL		14.399	2.576	9.220	0.705	1.717	0.000	0.360	0.914	0.000	0.000	0.127		
SAMPLE C		1082	3864	1167	1329	1776	2088	2397	2712	3039	3237	3360		
G.DRY/CC.WET MUD		0.612	0.620	0.628	0.551	0.587	0.625	0.604	0.529	0.656	0.724	0.552		
G.IR/G.DRY MUD		1.15E-09	-80L	9.54E-10	2.66E-10	6.18E-10	5.18E-10	9.00E-11	4.05E-10	5.41E-10	3.92E-11	3.67E-10		
* DREDGE MATERIAL		4.297	0.000	3.273	0.000	1.551	1.037	0.000	0.455	1.157	0.000	0.262		
SAMPLE D		4149									4712			
G.DRY/CC.WET MUD		0.600									0.667			
G.IR/G.DRY MUD		5.74E-10									4.24E-10			
* DREDGE MATERIAL		1.323									0.552			
SAMPLE E														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
* DREDGE MATERIAL														
SAMPLE F														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
* DREDGE MATERIAL														
SAMPLE G		4150									4713			
G.DRY/CC.WET MUD		0.650									0.710			
G.IR/G.DRY MUD		1.52E-10									2.70E-10			
* DREDGE MATERIAL		0.000									0.000			
SAMPLE H														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
* DREDGE MATERIAL														

COORDINATES		HOLE NO.	LOCATION											
G A 3 10		7	SAN PABLO STRAIT											
SAMPLING DATES		11MAR74	20MAR74	24APR74	15MAY74	19JUN74	22JUL74	20AUG74	28SEP74	7OCT74	15NOV74	4DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		42.0	41.0	41.0	39.0	40.5	40.0	40.0	40.0	40.0	41.0	40.0	40.0	
THICKNESS OF LAYERS (IN)		1.5	0.2	1.5	1.5	0.0	0.5	0.0	0.0	6.0	1.0	0.0	0.0	
FLUFF		15.0	4.5	12.0	11.0	13.0	5.0	4.0	7.0	12.0	5.0	3.0	3.0	
ACTIVE		3.0	14.0	11.0	15.0	14.0	14.0	9.0	20.0	11.0	21.0	22.0	22.0	
INACTIVE														
SAMPLE A		1001	3787	1234	1492	1846	2005	2428	2725	2845	3352	3481	3481	
G. DRY/CC. WET MUD		0.703	0.450	0.517	0.914	1.307	0.840	0.708	1.095	0.846	0.684	0.746	0.746	
G. IR/G. DRY MUD		2.00E-08	5.87E-11	8.14E-10	2.98E-10	2.05E-10	5.80E-10	3.19E-10	3.64E-10	4.01E-11	2.11E-10	1.09E-10	1.09E-10	
Σ DREDGE MATERIAL		101.150	0.000	2.555	0.000	0.000	1.354	0.016	0.246	0.000	0.000	0.000	0.000	
SAMPLE B		1002	3788	1235	1493	1847	2006	2429	2726	2846	3353	3482	3482	
G. DRY/CC. WET MUD		1.148	0.924	1.358	0.514	1.520	0.900	0.575	1.014	1.041	0.562	0.372	0.372	
G. IR/G. DRY MUD		1.26E-08	-BOL-	1.01E-09	3.85E-10	3.30E-10	1.79E-10	1.87E-10	2.56E-10	-BOL-	-BOL-	3.29E-10	3.29E-10	
Σ DREDGE MATERIAL		63.036	0.000	3.585	0.355	0.070	0.000	0.000	0.000	0.000	0.000	0.066	0.066	
SAMPLE C		1003	3789	1236	1494	1848	2007	2430	2727	2847	3354	3483	3483	
G. DRY/CC. WET MUD		1.004	0.660	0.982	0.567	1.433	0.860	0.774	0.740	1.098	0.682	0.475	0.475	
G. IR/G. DRY MUD		3.43E-09	-BOL-	1.92E-09	4.36E-10	3.47E-10	4.41E-10	4.33E-11	3.75E-11	4.01E-10	1.95E-10	4.85E-10	4.85E-10	
Σ DREDGE MATERIAL		15.988	0.000	8.229	0.613	0.158	0.641	0.000	0.304	0.436	0.000	0.666	0.666	
SAMPLE D		4891		4151	4153				4155	4157				
G. DRY/CC. WET MUD		0.789		0.552	0.564				0.626	0.763				
G. IR/G. DRY MUD		5.61E-10		3.45E-10	2.34E-10				3.70E-10	3.34E-10				
Σ DREDGE MATERIAL		1.258		0.146	0.000				0.279	0.091				
SAMPLE E		1005							4156					
G. DRY/CC. WET MUD		1.230							0.762					
G. IR/G. DRY MUD		2.23E-08							4.71E-10					
Σ DREDGE MATERIAL		112.616							0.795					
SAMPLE F		1006		4152	4154						4158			
G. DRY/CC. WET MUD		0.921		0.723	0.671						1.251			
G. IR/G. DRY MUD		6.97E-09		2.30E-10	-BOL-						4.48E-10			
Σ DREDGE MATERIAL		34.133		0.000	0.000						0.678			
SAMPLE G		4892												
G. DRY/CC. WET MUD		0.777												
G. IR/G. DRY MUD		-BOL-												
Σ DREDGE MATERIAL		0.000												
SAMPLE H														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														

[illegible]



COORDINATES		HOLE LOCATION									
F G 7 1		NO. 10 PINOLE SHOAL									
SAMPLING DATES		11MAR74 19MAR74 19APR74 13MAY74 19JUN74 11JUL74 16AUG74 12SEP74 7OCT74 14NOV74 4DEC74									
DEPTH OF SEDIMENT BELOW MLLW (FT)		42.0 39.0 37.0 37.0 36.5 35.0 35.5 38.0 37.5 37.5									
THICKNESS OF LAYERS (IN)											
FLUFF		1.0 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0									
ACTIVE		12.0 16.0 10.0 5.0 10.0 9.0 9.0 8.0 7.0 5.5									
INACTIVE		9.0 3.0 0.0 16.0 9.0 11.0 8.0 7.0 9.0 11.0									
SAMPLE A		1114 3718 1255 1432 1813 1885 2419 2665 2947 3184 3475									
G. DRY/CC.WET MUD		0.425 0.645 0.934 0.841 1.730 1.335 1.854 0.927 0.904 0.721 0.898									
G. IR/G. DRY MUD		1.27E-09 1.70E-10 7.11E-10 1.51E-09 1.91E-10 1.99E-10 1.96E-10 1.09E-10 5.85E-09 6.27E-11 -BDL -									
Σ DREDGE MATERIAL		4.890 0.000 2.027 6.145 0.000 0.000 0.000 0.000 28.403 0.000 0.000									
SAMPLE B		1115 3719 1256 1433 1814 1886 2420 2666 2948 3185 3476									
G. DRY/CC.WET MUD		1.278 1.379 1.446 1.357 1.608 2.001 1.494 1.477 1.110 0.907 0.975									
G. IR/G. DRY MUD		1.20E-09 1.29E-10 4.08E-10 5.43E-10 1.71E-10 1.53E-10 2.32E-10 -BDL -									
Σ DREDGE MATERIAL		4.551 0.000 0.474 1.166 0.000 0.000 0.000 0.000 14.652 9.042 0.000									
SAMPLE C		1116 3720 1257 1434 1815 1887 2421 2667 2949 3186 3477									
G. DRY/CC.WET MUD		1.121 1.315 1.477 0.628 1.033 0.975 1.382 1.325 0.881 1.225 1.012									
G. IR/G. DRY MUD		9.87E-10 1.49E-10 5.24E-10 4.78E-10 3.39E-10 1.90E-10 6.57E-11 3.04E-10 5.61E-09 2.69E-10 1.12E-10									
Σ DREDGE MATERIAL		3.439 0.000 1.066 0.833 0.118 0.000 0.000 0.000 27.173 0.000 0.000									
SAMPLE D		4518 4163 4176 4172 4171 4174									
G. DRY/CC.WET MUD		1.324 1.072 0.884 1.089 0.795 1.102									
G. IR/G. DRY MUD		1.08E-10 -BDL - 1.11E-10 3.19E-10 2.13E-10 -BDL -									
Σ DREDGE MATERIAL		0.000 0.000 0.000 0.016 0.000 0.000									
SAMPLE E		4173 4175 4176 4177 4178 4179									
G. DRY/CC.WET MUD		0.876 0.933 0.933 0.933 0.933 0.933									
G. IR/G. DRY MUD		3.60E-10 1.82E-10 1.82E-10 1.82E-10 1.82E-10 1.82E-10									
Σ DREDGE MATERIAL		0.226 0.000 0.000 0.000 0.000 0.000									
SAMPLE F		4184 4177 4178 4179 4180 4181									
G. DRY/CC.WET MUD		0.730 1.209 1.209 1.209 1.209 1.209									
G. IR/G. DRY MUD		1.42E-10 4.36E-11 4.36E-11 4.36E-11 4.36E-11 4.36E-11									
Σ DREDGE MATERIAL		0.000 0.000 0.000 0.000 0.000 0.000									
SAMPLE G		4182 4183 4184 4185 4186 4187									
G. DRY/CC.WET MUD		0.876 0.933 0.933 0.933 0.933 0.933									
G. IR/G. DRY MUD		3.60E-10 1.82E-10 1.82E-10 1.82E-10 1.82E-10 1.82E-10									
Σ DREDGE MATERIAL		0.226 0.000 0.000 0.000 0.000 0.000									
SAMPLE H		4188 4189 4190 4191 4192 4193									
G. DRY/CC.WET MUD		0.876 0.933 0.933 0.933 0.933 0.933									
G. IR/G. DRY MUD		3.60E-10 1.82E-10 1.82E-10 1.82E-10 1.82E-10 1.82E-10									
Σ DREDGE MATERIAL		0.226 0.000 0.000 0.000 0.000 0.000									

COORDINATES			HOLE LOCATION												
F	7	5	NO.	11	PINOLE SHOAL										
SAMPLING DATES					8MAR74	18MAR74	15APR74	13MAY74	19JUN74	11JUL74	16AUG74	12SEP74	7OCT74	1NOV74	4DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)					40.0	40.0	39.0	37.0	38.5	40.0	39.0	38.0	39.0	40.0	39.0
THICKNESS OF LAYERS (IN)					3.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	9.0	0.0	0.0
FLUFF					15.0	10.0	10.0	14.0	13.0	13.0	16.5	18.0	0.0	3.0	14.0
ACTIVE					0.0	0.0	0.0	0.0	0.0	4.0	6.0	0.0	0.0	7.0	0.0
INACTIVE															
SAMPLE A					1105	3808	1132	1453	1849	1909	2413	2668	2854	3220	3355
G.DRY/CC.WET MUD					0.284	0.731	1.453	1.318	1.677	1.142	1.832	1.316	0.914	0.792	0.722
G.IR/G.DRY MUD					1.99E-09	1.72E-09	1.34E-09	5.99E-10	2.09E-10	2.60E-10	1.08E-10	1.74E-10	6.05E-11	2.24E-10	2.72E-10
Σ DREDGE MATERIAL					8.592	7.186	5.269	1.450	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE B					1106	3809	1133	1454	1850	1910	2414	2669	2855	3221	3356
G.DRY/CC.WET MUD					0.788	1.581	1.228	1.509	1.211	1.566	1.599	1.346	1.522	1.240	1.285
G.IR/G.DRY MUD					2.61E-08	2.59E-09	1.58E-09	2.31E-10	1.35E-10	1.89E-10	5.27E-11	-BOL-	-BOL-	2.42E-10	2.6E-11
Σ DREDGE MATERIAL					132.494	11.667	6.484	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE C					1107	3810	1134	1455	1851	1911	2415	2670	2856	3222	3357
G.DRY/CC.WET MUD					1.276	1.503	1.296	1.360	1.433	1.220	1.476	1.666	0.792	0.573	1.671
G.IR/G.DRY MUD					1.21E-09	6.17E-10	1.27E-09	3.54E-10	9.84E-11	4.10E-10	3.25E-10	2.51E-10	-BOL-	2.22E-10	2.98E-10
Σ DREDGE MATERIAL					4.587	1.542	4.894	0.193	0.000	0.481	0.045	0.000	0.000	0.000	0.000
SAMPLE D					4520		4522	0507		4178					
G.DRY/CC.WET MUD					0.580		1.461	1.399		1.161					
G.IR/G.DRY MUD					-BOL-		4.35E-11	3.67E-10		1.61E-10					
Σ DREDGE MATERIAL					0.000		0.000	0.261		0.000					
SAMPLE E					4521					4179					
G.DRY/CC.WET MUD					1.799					0.857					
G.IR/G.DRY MUD					-BOL-					7.84E-11					
Σ DREDGE MATERIAL					0.000					0.000					
SAMPLE F								0508							
G.DRY/CC.WET MUD								1.125							
G.IR/G.DRY MUD								3.48E-10							
Σ DREDGE MATERIAL								0.162							
SAMPLE G															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE H															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															

COORDINATES F H 7 8	HOLE NO.	LOCATION	8MAR74	19MAR74	22APR74	5MAY74	4JUN74	23JUL74	5AUG74	9SEP74	7OCT74	1NOV74	6DEC74
	12	PINOLE SHOAL											
SAMPLING DATES			8MAR74	19MAR74	22APR74	5MAY74	4JUN74	23JUL74	5AUG74	9SEP74	7OCT74	1NOV74	6DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)			21.0	19.0	16.0	16.0	17.0	18.0	16.5	17.0	16.0	17.0	17.0
THICKNESS OF LAYERS (IN)													
FLUFF			0.5	0.2	1.5	1.0	2.0	0.0	1.0	1.0	2.0	0.0	0.0
ACTIVE			12.0	18.0	7.0	3.0	11.0	16.0	17.0	7.0	8.0	7.0	3.0
INACTIVE			0.0	0.0	16.0	12.0	5.0	4.0	7.0	3.0	9.0	2.0	17.0
SAMPLE A			3685	3781	1264	1378	1582	2023	2269	2608	2857	3061	3457
G.DRY/CC.WET MUD			1.511	0.562	0.412	0.584	1.124	0.623	0.620	0.745	0.653	0.552	0.689
G.IR/G.DRY MUD			6.32E-10	7.86E-10	4.67E-10	8.42E-10	3.57E-10	3.29E-10	2.98E-10	4.16E-11	1.00E-10	4.08E-10	4.57E-10
* DREDGE MATERIAL			1.619	2.409	0.777	2.696	0.210	0.069	0.000	0.000	0.000	0.475	0.724
SAMPLE B			3686	3782	1265	1379	1583	2024	2270	2609	2858	3062	3458
G.DRY/CC.WET MUD			1.672	0.593	0.641	0.521	0.523	0.524	0.553	0.558	0.664	0.559	0.418
G.IR/G.DRY MUD			5.41E-10	1.42E-10	9.27E-10	7.68E-10	2.94E-10	4.30E-10	-BOL-	1.04E-10	6.18E-11	8.41E-10	-BOL-
* DREDGE MATERIAL			1.152	0.000	3.135	2.318	0.000	0.585	0.000	0.000	0.000	2.692	0.000
SAMPLE C			3687	3783	1266	1380	1584	2025	2271	2610	2859	3063	3459
G.DRY/CC.WET MUD			1.345	0.396	0.575	0.886	0.587	0.575	0.561	0.788	0.466	0.578	0.329
G.IR/G.DRY MUD			2.65E-10	3.25E-10	5.02E-10	6.77E-10	3.03E-10	2.71E-10	2.01E-10	5.17E-10	-BOL-	1.15E-09	3.92E-11
* DREDGE MATERIAL			0.000	0.047	0.955	1.850	0.000	0.000	0.000	1.028	0.000	4.281	0.000
SAMPLE D					4212	4622		4182		4180			
G.DRY/CC.WET MUD					0.651	0.651		0.672		0.479			
G.IR/G.DRY MUD					2.37E-10	0.00E+00		2.91E-10		3.01E-10			
* DREDGE MATERIAL					0.000	0.000		0.000		0.000			
SAMPLE E								4183					
G.DRY/CC.WET MUD								0.542					
G.IR/G.DRY MUD								-BOL-					
* DREDGE MATERIAL								0.000					
SAMPLE F					4213					4181			
G.DRY/CC.WET MUD					0.485					0.797			
G.IR/G.DRY MUD					8.47E-11					6.94E-11			
* DREDGE MATERIAL					0.000					0.000			
SAMPLE G													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													

COORDINATES			HOLE NO.		LOCATION										
F	E	8	4	13	CARQUINEZ STRAIT										
SAMPLING DATES					8MAR74	19MAR74	5APR74	5MAY74	4JUN74	23JUL74	5AUG74	3SEP74	9OCT74	1NOV74	6DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)					12.5	17.0	19.5	17.0	15.5	15.5	14.5	12.5	18.0	16.5	17.0
THICKNESS OF LAYERS (IN)															
FLUFF					0.3	0.0	1.0	1.0	1.5	1.0	0.5	2.0	2.0	1.0	0.0
ACTIVE					16.0	12.0	15.0	7.0	11.5	10.0	10.0	8.0	9.0	11.0	2.0
INACTIVE					4.0	14.0	10.0	12.0	2.0	4.0	9.0	12.0	14.0	12.0	20.0
SAMPLE A					1099	3721	3697	1360	1606	2026	2236	2500	2890	3064	3451
G. DRY/CC. WET MUD					0.392	0.668	0.547	0.775	0.641	0.644	0.493	0.711	0.771	0.496	0.595
G. IR/G. DRY MUD					1.91E-09	4.40E-10	2.29E-10	1.68E-09	7.94E-10	6.08E-11	5.53E-10	1.10E-10	3.25E-10	1.32E-10	5.27E-10
Σ DREDGE MATERIAL					8.174	0.638	0.000	7.014	2.452	0.000	1.214	0.000	0.045	0.000	1.081
SAMPLE B					1101	3722	3698	1361	1607	2027	2237	2501	2891	3065	3452
G. DRY/CC. WET MUD					0.608	0.529	0.549	0.542	0.577	0.546	0.589	0.499	0.530	0.627	0.485
G. IR/G. DRY MUD					2.34E-09	2.00E-09	1.44E-09	4.58E-10	3.54E-10	2.80E-11	7.28E-11	7.52E-11	7.87E-10	1.29E-10	3.79E-11
Σ DREDGE MATERIAL					10.371	8.649	5.761	0.728	0.195	0.000	0.000	2.233	2.416	0.000	0.000
SAMPLE C					1100	3723	3699	1362	1608	2028	2238	2502	2892	3066	3453
G. DRY/CC. WET MUD					0.675	0.605	0.581	0.559	0.624	0.585	0.569	0.478	0.560	0.591	0.566
G. IR/G. DRY MUD					2.03E-09	-80L -	2.24E-11	1.54E-09	2.50E-10	-80L -	1.92E-10	3.33E-10	3.87E-10	2.95E-10	2.36E-10
Σ DREDGE MATERIAL					8.808	0.000	0.000	6.282	0.000	0.000	0.000	0.088	0.363	0.000	0.000
SAMPLE D					4623			4630	4184			4186	4188		
G. DRY/CC. WET MUD					0.623			0.638	0.521			0.538	0.622		
G. IR/G. DRY MUD					3.10E-10			1.17E-10	1.72E-10			1.88E-10	1.14E-10		
Σ DREDGE MATERIAL					0.000			0.000	0.000			0.000	0.000		
SAMPLE E															
G. DRY/CC. WET MUD															
G. IR/G. DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE F					4624			4631	4185						
G. DRY/CC. WET MUD					0.623			0.666	0.485						
G. IR/G. DRY MUD					2.30E-10			6.80E-10	2.69E-10						
Σ DREDGE MATERIAL					0.000			1.864	0.000						
SAMPLE G															
G. DRY/CC. WET MUD															
G. IR/G. DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE H															
G. DRY/CC. WET MUD															
G. IR/G. DRY MUD															
Σ DREDGE MATERIAL															

COORDINATES	HOLE NO.	LOCATION
F C B 3	14	CARQUINEZ STRAIT
SAMPLING DATES	18MAR74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	43.0	
THICKNESS OF LAYERS (IN)	0.0	
FLUFF	9.0	
ACTIVE	9.0	
INACTIVE	9.0	
SAMPLE A	3751	
G. DRY/CC. WET MUD	1.126	
G. IR/G. DRY MUD	1.43E-10	
* DREDGE MATERIAL	0.000	
SAMPLE B	3752	
G. DRY/CC. WET MUD	1.082	
G. IR/G. DRY MUD	7.93E-10	
* DREDGE MATERIAL	2.446	
SAMPLE C	3753	
G. DRY/CC. WET MUD	1.441	
G. IR/G. DRY MUD	1.16E-10	
* DREDGE MATERIAL	0.000	
SAMPLE D		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE E		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE F		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE G		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE H		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		

COORDINATES	HOLE	LOCATION
F C 7 8	NO. 15	PINOLE SHOAL
SAMPLING DATES	22MAR74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	40.5	
THICKNESS OF LAYERS (IN)	0.3	
FLUFF	11.0	
ACTIVE	9.0	
INACTIVE		
SAMPLE A	3793	
G. DRY/CC. WET MUD	0.326	
G. IR/G. DRY MUD	4.22E-10	
* DREDGE MATERIAL	0.544	
SAMPLE B	3794	
G. DRY/CC. WET MUD	1.254	
G. IR/G. DRY MUD	1.93E-09	
* DREDGE MATERIAL	8.280	
SAMPLE C	3795	
G. DRY/CC. WET MUD	1.242	
G. IR/G. DRY MUD	1.69E-09	
* DREDGE MATERIAL	7.049	
SAMPLE D		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE E		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE F		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE G		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE H		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		

COORDINATES		HOLE NO.	LOCATION
E	H	3	16 SAN PABLO BAY FLATS
SAMPLING DATES		11MAR74	18MAR74
DEPTH OF SEDIMENT BELOW MLLW (FT)		24.0	15.0
THICKNESS OF LAYERS (IN)			
FLUFF		0.5	0.3
ACTIVE		16.0	15.0
INACTIVE		5.0	0.0
SAMPLE A			
G.DRY/CC.WET MUD		1048	3754
G.IR/G.DRY MUD		0.322	0.728
X DREDGE MATERIAL		3.80E-09	5.82E-11
		17.877	0.000
SAMPLE B			
G.DRY/CC.WET MUD		1050	3755
G.IR/G.DRY MUD		0.937	1.165
X DREDGE MATERIAL		7.92E-09	1.00E-09
		38.990	3.526
SAMPLE C			
G.DRY/CC.WET MUD		1049	3756
G.IR/G.DRY MUD		0.759	1.281
X DREDGE MATERIAL		3.48E-09	1.16E-10
		16.217	0.000
SAMPLE D			
G.DRY/CC.WET MUD		4523	4878
G.IR/G.DRY MUD		0.806	0.753
X DREDGE MATERIAL		3.18E-11	4.26E-12
		0.000	0.000
SAMPLE E			
G.DRY/CC.WET MUD		4524	
G.IR/G.DRY MUD		1.069	
X DREDGE MATERIAL		1.45E-10	
		0.000	
SAMPLE F			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
X DREDGE MATERIAL			
SAMPLE G			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
X DREDGE MATERIAL			
SAMPLE H			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
X DREDGE MATERIAL			

COORDINATES		HOLE NO	LOCATION											
F	C	B	17	CARQUINEZ STRAIT										
SAMPLING DATES					8MAY74	5MAY74	4JUN74	23JUL74	5AUG74	30SEP74	9OCT74	1NOV74	6DEC74	
DEPTH OF SEDIMENT BELOW MLW (FT)					26.0	32.0	30.0	27.0	28.5	27.5	23.5	27.5	27.5	28.0
THICKNESS OF LAYERS (IN)														
FLUFF					0.4	0.1	0.5	0.8	0.5	0.0	0.0	0.0	2.0	1.0
ACTIVE					17.0	9.0	20.0	10.0	7.0	4.0	5.0	10.0	7.0	12.0
INACTIVE					0.0	14.0	8.0	12.0	6.0	6.0	14.0	10.0	8.0	12.0
SAMPLE A					1075	3811	3700	1363	1681	2029	2251	2746	2893	3067
G. DRY/CC. WET MUD					0.527	0.552	0.905	1.035	0.754	0.650	0.845	1.067	0.806	0.584
G. IR/G. DRY MUD					3.03E-09	4.24E-10	4.12E-10	4.12E-10	5.41E-10	3.87E-10	4.23E-10	3.04E-10	4.90E-10	5.97E-10
Σ DREDGE MATERIAL					13.900	0.554	0.000	0.494	1.157	0.364	0.547	0.000	0.895	1.439
SAMPLE B					1077	3812	3701	1364	1682	2030	2252	2747	2894	3068
G. DRY/CC. WET MUD					0.693	0.900	0.848	1.069	1.071	0.794	0.801	0.811	0.763	0.782
G. IR/G. DRY MUD					1.96E-09	7.59E-10	6.14E-10	9.96E-10	2.42E-10	3.26E-10	1.69E-10	3.60E-10	1.77E-09	1.66E-10
Σ DREDGE MATERIAL					8.413	2.271	1.530	3.435	0.000	0.050	0.000	0.225	7.457	0.000
SAMPLE C					1076	3813	3702	1365	1683	2031	2253	2748	2895	3069
G. DRY/CC. WET MUD					1.209	0.780	0.710	1.102	1.210	0.839	0.678	0.960	0.913	1.156
G. IR/G. DRY MUD					2.07E-09	1.15E-09	4.04E-10	1.25E-09	2.36E-09	6.48E-10	2.67E-10	7.24E-10	1.79E-09	8.01E-10
Σ DREDGE MATERIAL					9.013	4.286	0.449	4.803	10.501	1.704	0.000	2.092	7.549	0.000
SAMPLE D								4192	4196	0511		4190	4194	4744
G. DRY/CC. WET MUD								0.659	0.902	0.657		0.699	0.539	0.937
G. IR/G. DRY MUD								-BOL-	2.05E-10	4.19E-10		1.95E-10	1.21E-10	3.48E-10
Σ DREDGE MATERIAL								0.000	0.000	0.527		0.000	0.000	0.166
SAMPLE E										0512			4195	
G. DRY/CC. WET MUD										0.754			0.583	
G. IR/G. DRY MUD										4.65E-09		7.92E-11		
Σ DREDGE MATERIAL										22.204		0.000		
SAMPLE F								4193				4191		4745
G. DRY/CC. WET MUD								0.576				0.703		0.623
G. IR/G. DRY MUD								9.32E-11				1.53E-10		6.73E-09
Σ DREDGE MATERIAL								0.000				0.000		32.914
SAMPLE G														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														

COORDINATES			HOLE NO.	LOCATION									
E	D	3	18	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES			7MAR74	18MAR74	2APR74	2MAY74	3JUN74	9JUL74	1AUG74	3SEP74	1OCT74	5NOV74	13DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)			-NA-	7.0	7.0	6.5	5.0	6.0	4.5	5.0	5.0	4.5	6.0
THICKNESS OF LAYERS (IN)													
FLUFF			0.0	0.0	0.2	2.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
ACTIVE			9.0	15.0	12.0	4.0	10.0	7.0	5.0	4.0	5.0	6.0	4.0
INACTIVE			19.0	13.0	14.0	16.0	4.0	10.0	7.0	9.0	6.0	15.0	20.0
SAMPLE A			3760	3838	3688	1300	1612	1879	2152	2545	2764	3124	3388
G. DRY/CC. WET MUD			0.686	0.745	0.930	0.833	1.030	0.852	1.103	1.087	0.785	0.597	0.791
G. IR/G. DRY MUD			3.43E-10	4.19E-09	4.90E-10	5.01E-10	2.18E-10	2.33E-10	3.41E-10	4.94E-09	1.93E-10	-BOL-	1.31E-10
Σ DREDGE MATERIAL			0.138	19.850	0.891	0.947	0.000	0.000	0.126	23.723	0.000	0.000	0.000
SAMPLE B			3761	3839	3689	1301	1613	1880	2153	2546	2765	3125	3389
G. DRY/CC. WET MUD			0.807	0.732	0.872	0.667	1.220	0.690	1.136	0.863	1.000	0.740	0.554
G. IR/G. DRY MUD			4.74E-10	5.47E-10	3.77E-10	9.80E-10	2.84E-10	4.18E-10	1.49E-10	4.48E-10	0.00E+00	2.57E-10	2.59E-10
Σ DREDGE MATERIAL			0.810	1.186	0.312	3.403	0.000	0.524	0.000	0.675	0.000	0.000	0.000
SAMPLE C			3762	3840	3690	1302	1614	1881	2154	2547	2766	3126	3390
G. DRY/CC. WET MUD			0.619	0.795	0.602	0.491	1.234	0.803	0.909	1.519	1.374	0.660	0.618
G. IR/G. DRY MUD			2.95E-10	2.85E-10	6.78E-11	5.43E-10	2.89E-10	1.47E-10	3.61E-11	5.53E-09	-BOL-	6.70E-11	4.70E-10
Σ DREDGE MATERIAL			0.000	0.000	0.000	1.165	0.000	0.000	0.000	26.747	0.000	0.000	0.790
SAMPLE D						4197	4199			4201			
G. DRY/CC. WET MUD						0.425	0.985			0.797			
G. IR/G. DRY MUD						2.74E-10	-BOL-			-BOL-			
Σ DREDGE MATERIAL						0.000	0.000			0.000			
SAMPLE E													
G. DRY/CC. WET MUD							4200			4202			
G. IR/G. DRY MUD							0.872			0.582			
Σ DREDGE MATERIAL							3.30E-10			6.42E-11			
SAMPLE F						4198							
G. DRY/CC. WET MUD						0.419							
G. IR/G. DRY MUD						1.25E-10							
Σ DREDGE MATERIAL						0.000				0.000			
SAMPLE G													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE H													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													

COORDINATES			HOLE NO.	LOCATION									
E	F	B S	19	SAN PABLO BAY FLATS									
SAMPLING DATES			11MAR74	18MAR74	2APR74	1MAY74	3JUN74	9JUL74	1AUG74	3SEP74	1OCT74	5NOV74	6DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)			14.0	14.0	14.0	15.0	15.0	13.5	14.5	14.5	15.0	14.5	14.5
THICKNESS OF LAYERS (IN)													
FLUFF			0.5	0.0	0.2	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
ACTIVE			10.0	8.0	16.0	8.5	8.0	6.0	6.0	4.0	8.0	11.0	14.0
INACTIVE			9.0	0.0	5.0	14.0	9.0	16.0	12.0	16.0	10.0	10.0	11.0
SAMPLE A			1090	3715	3913	1312	1675	1891	2137	2467	2935	3127	3526
G.DRY/CC.WET MUD			0.607	0.629	0.694	1.085	1.155	1.002	0.759	1.443	0.800	0.670	1.074
G.IR/G.DRY MUD			4.66E-09	3.78E-10	1.76E-10	3.53E-10	6.72E-10	2.39E-10	2.95E-11	2.45E-10	9.05E-10	3.67E-11	2.11E-10
Σ DREDGE MATERIAL			22.297	0.321	0.000	0.191	1.826	0.000	0.000	0.000	3.020	0.000	0.000
SAMPLE B			1092	3716	3914	1313	1676	1892	2138	2468	2936	3128	3527
G.DRY/CC.WET MUD			1.394	1.000	0.822	1.085	1.309	1.129	1.128	1.285	0.990	1.061	1.237
G.IR/G.DRY MUD			4.79E-09	1.47E-09	2.95E-10	5.73E-10	6.60E-10	8.08E-11	3.45E-10	1.46E-10	1.65E-10	2.02E-10	3.01E-10
Σ DREDGE MATERIAL			22.937	5.929	0.000	1.318	1.767	0.000	0.146	0.000	0.000	0.000	0.000
SAMPLE C			1091	3717	3915	1314	1677	1893	2139	2469	2937	3129	3528
G.DRY/CC.WET MUD			0.798	1.001	0.970	1.112	0.935	0.792	0.950	0.937	1.099	1.043	1.384
G.IR/G.DRY MUD			3.33E-09	4.63E-11	3.14E-10	6.12E-10	3.05E-10	-BOL-	5.82E-10	1.84E-10	5.26E-10	1.87E-10	-BOL-
Σ DREDGE MATERIAL			15.461	0.000	0.000	1.520	0.000	0.000	1.362	0.000	1.076	0.000	0.000
SAMPLE D			4525			4214			4203		4205		
G.DRY/CC.WET MUD			0.796			0.810			0.844		0.894		
G.IR/G.DRY MUD			-BOL-			3.67E-10			7.34E-11		4.27E-10		
Σ DREDGE MATERIAL			0.000			0.263			0.000		0.571		
SAMPLE E									4204		4206		
G.DRY/CC.WET MUD									0.728		1.004		
G.IR/G.DRY MUD									3.68E-11		1.64E-10		
Σ DREDGE MATERIAL									0.000		0.000		
SAMPLE F						4215							
G.DRY/CC.WET MUD						0.722							
G.IR/G.DRY MUD						-BOL-							
Σ DREDGE MATERIAL						0.000							
SAMPLE G			4526										
G.DRY/CC.WET MUD			0.804										
G.IR/G.DRY MUD			-BOL-										
Σ DREDGE MATERIAL			0.000										
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													

COORDINATES		HOLE NO.	LOCATION
E	H	B	
		20	CARQUINEZ STRAIT
SAMPLING DATES		13MAR74	28MAR74
DEPTH OF SEDIMENT BELOW MLLW (FT)		47.0	43.0
THICKNESS OF LAYERS (IN)			
FLUFF			
ACTIVE			
INACTIVE			
SAMPLE A			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE B			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE C			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE D			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE E			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE F			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE G			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE H			
G.DRY/CC.WET MUD			
G.IR/G.DRY MUD			
Σ DREDGE MATERIAL			

## COORDINATES HOLE LOCATION

E B 7 10 NO. 21 SAN PABLO BAY FLATS

SAMPLING DATES 7MAR74 18MAR74 2APR74 2MAY74 11JUL74 30JUL74 23AUG74 30SEP74 17OCT74 5NOV74 13DEC74

DEPTH OF SEDIMENT BELOW MLLW (FT) -NA- 2.3 3.0 2.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

THICKNESS OF LAYERS (IN) FLUFF ACTIVE INACTIVE

SAMPLE A 1210 1213 1216 1219 1945 2146 2455 2749 3043 3130 3373  
G.DRY/CC.WET MUD 0.335 0.512 0.464 0.532 0.499 0.687 0.621 0.682 0.594 0.646 0.510  
G.IR/G.DRY MUD 4.01E-09 1.79E-09 7.05E-10 2.93E-10 1.80E-09 -BOL- -BOL- 1.76E-10 9.87E-11 7.14E-11 2.20E-10  
Σ DREDGE MATERIAL 18.927 7.548 1.996 0.000 7.619 0.000 0.000 0.000 0.000 0.000 0.000

SAMPLE B 1211 1214 1217 1220 1946 2147 2456 2750 3044 3131 3374  
G.DRY/CC.WET MUD 0.580 0.540 0.676 0.608 0.706 0.531 0.570 0.548 0.533 0.585 0.457  
G.IR/G.DRY MUD 4.95E-09 2.33E-09 6.48E-10 8.50E-10 1.03E-09 1.22E-10 1.48E-10 4.65E-10 6.61E-10 2.29E-10 1.92E-10  
Σ DREDGE MATERIAL 23.748 10.322 1.703 2.736 3.639 0.000 0.000 0.764 1.769 0.000 0.000

SAMPLE C 1212 1215 1218 1221 1947 2148 2457 2751 3045 3132 3375  
G.DRY/CC.WET MUD 0.582 0.633 0.595 0.597 0.592 0.636 0.647 0.667 0.607 0.663 0.596  
G.IR/G.DRY MUD 1.84E-09 1.86E-09 9.15E-10 8.54E-10 1.03E-09 1.43E-10 2.41E-10 3.74E-11 -BOL- -BOL- 5.00E-10  
Σ DREDGE MATERIAL 7.832 7.911 3.074 2.760 3.639 0.000 0.000 0.000 0.000 0.000 0.945

SAMPLE D 4207 4209 4210 4216 4224 4222 4226 4218 4220 4246 4248  
G.DRY/CC.WET MUD 0.570 0.582 0.699 0.365 0.677 0.656 0.563 0.522 0.518 0.684 0.681  
G.IR/G.DRY MUD 4.76E-10 5.27E-10 4.00E-10 2.32E-10 1.13E-10 4.50E-10 4.11E-10 2.81E-10 3.90E-10 6.60E-11 4.85E-11  
Σ DREDGE MATERIAL 0.821 1.084 0.432 0.000 0.000 0.685 0.487 0.000 0.380 0.000 0.000

SAMPLE E 4217 4225 4223 4227 4219  
G.DRY/CC.WET MUD 0.619 0.409 0.616 0.570 0.608  
G.IR/G.DRY MUD 1.08E-10 4.95E-10 4.58E-10 2.26E-10 3.70E-10  
Σ DREDGE MATERIAL 0.000 0.919 0.728 0.000 0.275

SAMPLE F 4208 4211 4211  
G.DRY/CC.WET MUD 0.597 0.662  
G.IR/G.DRY MUD 6.22E-11 1.73E-10  
Σ DREDGE MATERIAL 0.000 0.000

SAMPLE G 4221 4221  
G.DRY/CC.WET MUD 0.604 0.604  
G.IR/G.DRY MUD 2.29E-10 2.29E-10  
Σ DREDGE MATERIAL 0.000 0.000

SAMPLE H 4247 4249  
G.DRY/CC.WET MUD 0.700 0.509  
G.IR/G.DRY MUD 3.63E-10 2.76E-10  
Σ DREDGE MATERIAL 0.242 0.000

COORDINATES	HOLE NO.	LOCATION
E H 9 3	22	CARQUINEZ STRAIT
SAMPLING DATES	13MAR74	28MAR74
DEPTH OF SEDIMENT BELOW MLLW (FT)	49.0	48.0
THICKNESS OF LAYERS (IN)		
FLUFF	0.5	0.3
ACTIVE	9.0	25.0
INACTIVE	0.0	0.0
SAMPLE A	1063	3880
G.DRY/CC.WET MUD	0.593	0.736
G.IR/G.DRY MUD	5.70E-09	1.04E-09
* DREDGE MATERIAL	27.621	3.691
SAMPLE B	1065	3881
G.DRY/CC.WET MUD	0.968	1.321
G.IR/G.DRY MUD	2.97E-09	5.55E-10
* DREDGE MATERIAL	13.618	1.224
SAMPLE C	1064	3882
G.DRY/CC.WET MUD	0.740	0.886
G.IR/G.DRY MUD	3.07E-09	-80L
* DREDGE MATERIAL	14.104	0.000
SAMPLE D	4340	4874
G.DRY/CC.WET MUD	0.783	0.618
G.IR/G.DRY MUD	3.60E-10	2.17E-10
* DREDGE MATERIAL	0.225	0.000
SAMPLE E		
G.DRY/CC.WET MUD		
G.IR/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE F		
G.DRY/CC.WET MUD		
G.IR/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE G		4875
G.DRY/CC.WET MUD		0.862
G.IR/G.DRY MUD		2.08E-10
* DREDGE MATERIAL		0.000
SAMPLE H		4341
G.DRY/CC.WET MUD		0.668
G.IR/G.DRY MUD		5.06E-10
* DREDGE MATERIAL		0.972

COORDINATES	HOLE NO	LOCATION
E H 9 8	23	CARQUINEZ STRAIT
SAMPLING DATES	14MAR74	28MAR74 24APR74
DEPTH OF SEDIMENT BELOW MLW (FT)	-NA-	42.0 -NA-
THICKNESS OF LAYERS (IN)	-NA-	-NA-
FLUFF	-NA-	-NA-
ACTIVE	-NA-	-NA-
INACTIVE	-NA-	-NA-
<p>SAMPLE A</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE B</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE C</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE D</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE E</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE F</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE G</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		
<p>SAMPLE H</p> <p>G. DRY/CC. WET MUD</p> <p>G. IR/G. DRY MUD</p> <p>⌘ DREDGE MATERIAL</p>		

NO SAMPLES RECOVERED

COORDINATES	HOLE NO.	LOCATION										
E E 9 6	24	CARQUINEZ STRAIT										
SAMPLING DATES	14MAR74	28MAR74	24APR74	16MAY74	17JUN74	25JUL74	16AUG74	30SEP74	17OCT74	14NOV74	6OEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	47.9	48.0	49.0	47.0	47.5	47.0	47.5	48.0	47.0	47.0	47.0	
THICKNESS OF LAYERS (IN)												
FLUFF	1.0	0.1	2.5	1.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	
ACTIVE	24.0	20.0	12.5	5.0	9.0	5.0	10.0	6.0	10.0	5.0	7.0	
INACTIVE	0.0	5.0	10.0	8.0	6.0	7.0	8.0	13.0	10.0	16.0	17.0	
SAMPLE A	1051	3901	1276	1573	1786	2074	2416	2752	3013	3223	3424	
G. DRY/CC. WET MUD	0.419	0.754	0.432	0.731	0.994	0.802	1.545	0.785	0.639	0.456	1.158	
G. IR/G. DRY MUD	3.25E-09	2.49E-10	4.93E-10	3.39E-10	2.09E-10	4.27E-10	7.38E-12	1.18E-10	1.59E-10	5.93E-10	1.98E-10	
* DREDGE MATERIAL	15.025	0.000	0.909	0.116	0.000	0.567	0.000	0.000	0.000	1.420	0.000	
SAMPLE B	1053	3902	1277	1574	1787	2075	2417	2753	3014	3224	3425	
G. DRY/CC. WET MUD	0.754	0.639	0.783	1.331	1.180	0.984	1.485	1.414	0.689	0.692	1.191	
G. IR/G. DRY MUD	3.68E-09	6.60E-10	5.75E-10	2.50E-10	2.48E-10	2.58E-10	-BDL-	5.26E-11	2.53E-10	2.24E-10	9.33E-11	
* DREDGE MATERIAL	17.240	1.764	1.327	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SAMPLE C	1052	3903	1278	1575	1788	2076	2418	2754	3015	3225	3426	
G. DRY/CC. WET MUD	0.896	0.532	1.024	1.397	1.109	0.792	1.400	0.909	0.635	0.780	0.868	
G. IR/G. DRY MUD	4.64E-09	7.05E-11	4.25E-10	5.86E-10	1.74E-10	-BDL-	2.66E-10	-BDL-	1.41E-10	1.32E-10	1.12E-11	
* DREDGE MATERIAL	22.185	0.000	0.558	1.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SAMPLE D	4342		4229	4228								
G. DRY/CC. WET MUD	0.878		1.168	0.548								
G. IR/G. DRY MUD	2.69E-10		8.67E-11	3.99E-10								
* DREDGE MATERIAL	0.000		0.000	0.424								
SAMPLE E												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												
SAMPLE F	4343											
G. DRY/CC. WET MUD	0.751											
G. IR/G. DRY MUD	5.47E-10											
* DREDGE MATERIAL	1.186											
SAMPLE G			4230									
G. DRY/CC. WET MUD			1.161									
G. IR/G. DRY MUD			2.08E-10									
* DREDGE MATERIAL			0.000									
SAMPLE H												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
* DREDGE MATERIAL												

COORDINATES			HOLE NO.		LOCATION										
E	F	7	6	25	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES					7MAR74	18MAR74	2APR74	2MAY74	3JUN74	9JUL74	1AUG74	3SEP74	1OCT74	5NOV74	6DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)					-NA-	-NA-	-NA-	6.5	8.0	6.0	7.0	7.0	7.0	7.0	7.0
THICKNESS OF LAYERS (IN)					0.5	0.3	0.4	1.0	1.5	2.5	1.0	0.0	0.0	0.0	0.0
FLUFF					17.5	16.0	7.0	7.0	8.0	6.0	5.0	6.0	7.0	5.0	2.0
ACTIVE					0.0	0.0	14.0	7.0	8.0	3.0	12.0	11.0	7.0	10.0	17.0
INACTIVE															
SAMPLE A					1102	3757	3763	1315	1678	1873	2167	2503	2809	3133	3496
G.DRY/CC.WET MUD					0.583	0.804	0.707	0.848	0.858	0.731	0.715	0.991	0.907	0.784	0.925
G.IR/G.DRY MUD					2.82E-09	2.40E-10	6.03E-10	5.47E-10	2.58E-10	2.29E-10	1.01E-10	3.52E-10	2.61E-10	8.47E-11	2.64E-10
Σ DREDGE MATERIAL					12.844	0.000	1.473	1.183	0.000	0.000	0.000	0.187	0.000	0.000	0.000
SAMPLE B					1104	3758	3764	1316	1679	1874	2168	2504	2810	3134	3497
G.DRY/CC.WET MUD					0.802	0.675	0.649	0.891	0.793	0.702	0.782	0.853	0.750	0.832	0.837
G.IR/G.DRY MUD					1.78E-09	3.74E-10	-BOL-	4.09E-10	1.97E-10	1.67E-10	2.77E-11	1.43E-10	3.47E-10	3.71E-10	1.71E-10
Σ DREDGE MATERIAL					7.489	0.298	0.000	0.475	0.000	0.000	0.000	0.000	0.157	0.283	0.000
SAMPLE C					1103	3759	3765	1317	1680	1875	2169	2505	2811	3135	3498
G.DRY/CC.WET MUD					0.657	0.674	0.709	0.666	0.744	0.913	0.758	1.105	0.800	0.933	0.677
G.IR/G.DRY MUD					1.56E-09	3.43E-10	-BOL-	1.01E-09	3.08E-10	4.63E-10	3.99E-10	2.74E-10	1.34E-10	2.26E-10	6.35E-10
Σ DREDGE MATERIAL					6.366	0.138	0.000	3.562	0.000	0.753	0.426	0.000	0.000	0.000	1.634
SAMPLE D					4648			4231		4625			4233		4811
G.DRY/CC.WET MUD					0.868			0.729		0.744			0.722		0.842
G.IR/G.DRY MUD					4.46E-10			4.37E-10		3.10E-10			-BOL-		2.29E-10
Σ DREDGE MATERIAL					0.667			0.619		0.000			0.000		0.000
SAMPLE E								4232		4626					4812
G.DRY/CC.WET MUD								1.014		0.865					1.301
G.IR/G.DRY MUD								2.29E-10		5.56E-10					1.97E-10
Σ DREDGE MATERIAL								0.000		1.232					0.000
SAMPLE F					4649										
G.DRY/CC.WET MUD					0.743										
G.IR/G.DRY MUD					2.16E-10										
Σ DREDGE MATERIAL					0.000										
SAMPLE G															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE H															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															

COORDINATES		HOLE NO.	LOCATION
E	H 7 3	26	SAN PABLO BAY FLATS
SAMPLING DATES		11MAR74	19MAR74
DEPTH OF SEDIMENT BELOW MLLW (FT)		13.0	10.0
THICKNESS OF LAYERS (IN)			
FLUFF		0.5	0.0
ACTIVE		23.0	9.0
INACTIVE		0.0	13.0
SAMPLE A			
G. DRY/CC. WET MUD		1111	3724
G. IR/G. DRY MUD		0.420	0.647
G. IR/G. DRY MUD		9.28E-10	5.78E-10
Σ DREDGE MATERIAL		3.140	1.342
SAMPLE B			
G. DRY/CC. WET MUD		1112	3725
G. IR/G. DRY MUD		0.524	0.562
G. IR/G. DRY MUD		2.79E-09	4.58E-10
Σ DREDGE MATERIAL		12.682	0.730
SAMPLE C			
G. DRY/CC. WET MUD		1113	3726
G. IR/G. DRY MUD		0.438	0.535
G. IR/G. DRY MUD		2.55E-09	3.70E-10
Σ DREDGE MATERIAL		11.435	0.277
SAMPLE D			
G. DRY/CC. WET MUD		4234	
G. IR/G. DRY MUD		0.928	
G. IR/G. DRY MUD		1.85E-10	
Σ DREDGE MATERIAL		0.000	
SAMPLE E			
G. DRY/CC. WET MUD			
G. IR/G. DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE F			
G. DRY/CC. WET MUD			
G. IR/G. DRY MUD			
Σ DREDGE MATERIAL			
SAMPLE G			
G. DRY/CC. WET MUD		4235	
G. IR/G. DRY MUD		0.816	
G. IR/G. DRY MUD		-BOL-	
Σ DREDGE MATERIAL		0.000	
SAMPLE H			
G. DRY/CC. WET MUD			
G. IR/G. DRY MUD			
Σ DREDGE MATERIAL			

COORDINATES	HOLE NO.	LOCATION										
E E 6 5	27	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES	11MAR74	20MAR74	24PR74	2MAY74	3JUN74	9JUL74	2AUG74	3SEP74	17OCT74	5NOV74	13DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	7.0	5.5	5.5	7.0	7.5	6.5	6.5	6.0	6.5	7.0	7.0	
THICKNESS OF LAYERS (IN)												
FLUFF	4.5	3.0	2.5	2.0	2.0	2.0	2.0	0.0	1.0	0.0	1.0	
ACTIVE	18.0	5.0	10.0	7.0	6.0	6.0	6.0	6.0	5.0	7.0	6.0	
INACTIVE	0.0	14.0	15.0	10.0	9.0	9.0	10.0	10.0	12.0	12.0	16.0	
SAMPLE A	1108	3847	3916	1294	1642	1882	2218	2470	3016	3136	3466	
G.DRY/CC.WET MUD	0.314	0.610	0.871	0.675	0.608	0.555	0.488	0.771	0.571	0.504	0.581	
G.1R/G.DRY MUD	7.42E-10	1.98E-09	1.66E-10	3.77E-10	2.76E-10	4.23E-10	1.09E-10	2.75E-10	4.30E-10	1.94E-10	2.29E-09	
* DREDGE MATERIAL	2.184	8.548	0.000	0.312	0.000	0.547	0.000	0.000	0.586	0.000	10.135	
SAMPLE B	1109	3848	3917	1295	1643	1883	2219	2471	3017	3137	3467	
G.DRY/CC.WET MUD	0.553	0.747	0.496	0.682	0.595	0.590	0.677	0.773	0.646	0.720	0.611	
G.1R/G.DRY MUD	2.75E-09	1.74E-09	1.86E-10	4.12E-10	2.05E-10	1.19E-10	2.70E-11	-BOL-	-BOL-	1.68E-10	7.93E-12	
* DREDGE MATERIAL	12.493	7.323	0.000	0.494	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SAMPLE C	1110	3849	3918	1296	1644	1884	2220	2472	3018	3138	3468	
G.DRY/CC.WET MUD	0.605	0.843	0.681	0.673	0.784	0.668	0.821	0.737	0.686	0.698	0.853	
G.1R/G.DRY MUD	6.40E-10	1.11E-09	5.48E-10	2.04E-10	-BOL-	2.54E-10	5.27E-10	2.87E-10	1.87E-10	4.19E-12	3.17E-10	
* DREDGE MATERIAL	1.659	4.061	1.192	0.000	0.000	0.000	1.083	0.000	0.000	0.000	0.007	
SAMPLE D	4527											
G.DRY/CC.WET MUD	0.768											
G.1R/G.DRY MUD	1.90E-10											
* DREDGE MATERIAL	0.000											
SAMPLE E	4528											
G.DRY/CC.WET MUD	0.766											
G.1R/G.DRY MUD	1.34E-10											
* DREDGE MATERIAL	0.000											
SAMPLE F	4237											
G.DRY/CC.WET MUD	0.743											
G.1R/G.DRY MUD	-BOL-											
* DREDGE MATERIAL	0.000											
SAMPLE G	4237											
G.DRY/CC.WET MUD	0.743											
G.1R/G.DRY MUD	-BOL-											
* DREDGE MATERIAL	0.000											
SAMPLE H	4237											
G.DRY/CC.WET MUD	0.743											
G.1R/G.DRY MUD	-BOL-											
* DREDGE MATERIAL	0.000											

COORDINATES	HOLE NO.	LOCATION
F C 3	28	PINOLE SHOAL
SAMPLING DATES	11MAR74	22MAR74
DEPTH OF SEDIMENT BELOW MLLW (FT)	22.0	18.0
THICKNESS OF FLUFF LAYERS (IN)	1.3	0.5
ACTIVE	8.0	18.0
INACTIVE	8.0	0.0
SAMPLE A	1087	3826
G.DRY/CC.WET MUD	0.380	0.826
G.IR/G.DRY MUD	1.54E-09	1.63E-09
* DREDGE MATERIAL	6.271	6.721
SAMPLE B	1069	3827
G.DRY/CC.WET MUD	0.702	0.616
G.IR/G.DRY MUD	1.32E-09	1.43E-09
* DREDGE MATERIAL	5.147	5.717
SAMPLE C	1088	3828
G.DRY/CC.WET MUD	0.583	0.585
G.IR/G.DRY MUD	2.31E-09	1.00E-09
* DREDGE MATERIAL	10.206	3.507
SAMPLE D	4652	
G.DRY/CC.WET MUD	0.626	
G.IR/G.DRY MUD	4.44E-10	
* DREDGE MATERIAL	0.659	
SAMPLE E		
G.DRY/CC.WET MUD		
G.IR/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE F	4653	
G.DRY/CC.WET MUD	0.957	
G.IR/G.DRY MUD	3.87E-10	
* DREDGE MATERIAL	0.367	
SAMPLE G		
G.DRY/CC.WET MUD		
G.IR/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE H		
G.DRY/CC.WET MUD		
G.IR/G.DRY MUD		
* DREDGE MATERIAL		

COORDINATES		HOLE NO.	LOCATION											
F	E	6	29	PINOLE SHOAL										
SAMPLING DATES		11MAR74	22MAR74	31APR74	13MAY74	4JUN74	24JUL74	23AUG74	30SEP74	9OCT74	6NOV74	4DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		25.0	25.5	26.0	24.5	28.5	25.0	25.0	25.5	26.0	25.5	26.0		
THICKNESS OF LAYERS (IN)														
FLUFF		-NA-	0.2	0.4	2.0	2.0	0.0	0.0	1.0	2.0	0.0	0.0		
ACTIVE		-NA-	22.0	21.0	7.0	7.0	6.0	3.0	5.0	5.0	8.0	4.0		
INACTIVE		-NA-	0.0	0.0	12.0	0.0	12.0	17.0	13.0	15.0	13.0	23.0		
SAMPLE A		3796	3769	1465	1684	2179	2449	2755	2863	3148	3493	3493		
G. DRY/CC. WET MUD		NO	0.475	0.550	0.622	0.586	0.806	0.999	0.982	0.633	0.615	0.709		
G. IR/G. DRY MUD		SAMPLE	6.36E-09	3.04E-10	4.06E-10	6.15E-10	3.20E-11	2.40E-10	1.62E-10	1.55E-10	-BOL-	-BOL-		
Σ DREDGE MATERIAL		30.990	0.000	0.462	1.532	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
SAMPLE B		3797	3770	1466	1685	2180	2450	2756	2864	3149	3494	3494		
G. DRY/CC. WET MUD		NO	0.752	0.503	0.666	1.072	0.905	1.049	0.832	0.525	0.678	1.072		
G. IR/G. DRY MUD		SAMPLE	6.62E-10	5.05E-10	4.46E-10	2.73E-10	1.10E-10	3.50E-10	-BOL-	2.73E-10	2.84E-10	3.01E-10		
Σ DREDGE MATERIAL		1.773	0.967	0.668	0.000	0.000	0.174	0.000	0.000	0.000	0.000	0.000		
SAMPLE C		3798	3771	1467	1686	2181	2451	2757	2865	3150	3495	3495		
G. DRY/CC. WET MUD		NO	0.752	0.944	1.081	1.263	0.928	1.011	0.930	1.340	1.002	0.967		
G. IR/G. DRY MUD		SAMPLE	2.41E-09	5.19E-11	6.80E-10	4.15E-11	2.44E-10	1.08E-10	-BOL-	1.10E-10	3.25E-10	4.33E-10		
Σ DREDGE MATERIAL		10.735	0.000	1.869	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.601		
SAMPLE D		4238												
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE E		4815												
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE F		4816												
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE G		4815												
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H		4816												
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														

COORDINATES		HOLE NO.	LOCATION											
G E	6	30	PINOLE SHOAL (STAKED)											
SAMPLING DATES			11MAR74	19MAR74	11APR74	5MAY74	5JUN74	10JUL74	1AUG74	4SEP74	11OCT74	22NOV74	17DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)			8.0	7.0	7.0	6.5	5.5	5.5	6.0	6.0	6.5	6.5	6.0	
THICKNESS OF LAYERS (IN)														
FLOFF			3.0	0.4	1.0	2.0	1.5	1.0	1.0	1.0	2.0	0.0	1.0	
ACTIVE			15.0	22.0	10.0	6.0	9.0	5.0	10.0	8.0	7.0	7.0	5.0	
INACTIVE			0.0	0.0	10.0	10.0	10.0	11.0	9.0	3.0	11.0	10.0	19.0	
SAMPLE A			1069	3784	3664	1375	1627	1903	2275	2518	2878	3340	3619	
G.DRY/CC.WET MUD			0.305	0.639	0.697	0.674	0.633	0.627	0.712	0.650	0.607	0.537	0.632	
G.IR/G.DRY MUD			2.03E-09	1.04E-09	9.47E-10	3.36E-10	1.72E-10	3.13E-10	3.83E-10	2.10E-10	1.52E-10	2.18E-10	2.00E-10	
X DREDGE MATERIAL			8.770	3.702	3.234	0.101	0.000	0.000	0.343	0.000	0.000	0.000	0.000	
SAMPLE B			1071	3785	3665	1376	1628	1904	2276	2519	2879	3341	3620	
G.DRY/CC.WET MUD			0.791	0.466	0.572	0.617	0.552	0.674	0.550	0.561	0.593	0.570	0.589	
G.IR/G.DRY MUD			2.86E-09	1.49E-09	7.53E-10	3.43E-10	1.04E-09	4.44E-10	3.12E-10	3.42E-10	2.58E-10	1.69E-10	9.15E-11	
X DREDGE MATERIAL			13.032	6.033	2.241	0.138	3.713	0.659	0.000	0.132	0.000	0.000	0.000	
SAMPLE C			1070	3786	3666	1377	1629	1905	2277	2520	2880	3342	3621	
G.DRY/CC.WET MUD			0.537	0.672	0.630	0.573	0.681	0.549	0.624	0.629	0.619	0.535	0.528	
G.IR/G.DRY MUD			1.85E-09	4.59E-10	1.32E-09	3.50E-10	3.96E-10	3.54E-10	5.04E-10	8.30E-10	0.00E+00	1.92E-10	-BDL	
X DREDGE MATERIAL			7.861	0.733	5.167	0.176	0.411	0.195	0.963	2.638	0.000	0.000	0.000	
SAMPLE D			4344	4873	4240	4240	4243	4242	4244	4246				
G.DRY/CC.WET MUD			0.609	0.507	0.646	0.619	0.619	0.590	0.592	0.617				
G.IR/G.DRY MUD			3.66E-10	7.24E-11	1.03E-10	-BDL	-BDL	3.16E-10	1.50E-10	2.92E-10				
X DREDGE MATERIAL			0.259	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
SAMPLE E						4241			4245					
G.DRY/CC.WET MUD						0.535			0.501					
G.IR/G.DRY MUD						1.54E-10			3.28E-10					
X DREDGE MATERIAL						0.000			0.063					
SAMPLE F														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
X DREDGE MATERIAL														
SAMPLE G														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
X DREDGE MATERIAL														
SAMPLE H														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
X DREDGE MATERIAL														

4247  
0.643  
1.33E-10  
0.000

COORDINATES	HOLE NO.	LOCATION
G C 8	31	PINOLE SHOAL
SAMPLING DATES	11MAR74	19MAR74
DEPTH OF SEDIMENT BELOW MLH (FT)	19.0	12.0
THICKNESS OF LAYERS (IN)		
FLUFF	2.0	0.0
ACTIVE	14.0	21.0
INACTIVE	0.0	0.0
SAMPLE A	1072	3841
G. DRY/CC. WET MUD	0.351	0.690
G. IR/G. DRY MUD	3.07E-09	9.75E-10
Σ DREDGE MATERIAL	14.144	3.382
SAMPLE B	1074	3842
G. DRY/CC. WET MUD	0.463	0.610
G. IR/G. DRY MUD	3.89E-09	1.46E-09
Σ DREDGE MATERIAL	18.338	5.851
SAMPLE C	1073	3843
G. DRY/CC. WET MUD	0.626	0.476
G. IR/G. DRY MUD	2.71E-09	1.18E-09
Σ DREDGE MATERIAL	12.271	4.431
SAMPLE D	4345	
G. DRY/CC. WET MUD	0.582	
G. IR/G. DRY MUD	4.49E-10	
Σ DREDGE MATERIAL	0.684	
SAMPLE E		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
Σ DREDGE MATERIAL		
SAMPLE F		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
Σ DREDGE MATERIAL		
SAMPLE G		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
Σ DREDGE MATERIAL		
SAMPLE H		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
Σ DREDGE MATERIAL		

COORDINATES		HOLE NO.	LOCATION									
G C	7 3	32	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES		13MAR74	26MAR74	11APR74	3MAY74	10JUN74	10JUL74	1AUG74	16SEP74	20OCT74	22NOV74	12DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		5.0	6.0	5.5	4.0	5.0	4.5	5.5	5.5	5.0	5.5	6.0
THICKNESS OF LAYERS (IN)												
FLUFF		1.0	1.1	1.0	1.0	2.0	2.0	1.0	0.0	1.0	0.0	1.0
ACTIVE		10.0	12.0	11.0	4.0	8.0	6.0	11.0	10.0	9.0	5.0	3.0
INACTIVE		11.0	13.0	8.0	15.0	6.0	7.0	13.0	9.0	6.0	15.0	14.0
SAMPLE A		3871	3829	3667	1366	1720	1939	2278	2671	2815	3337	3385
G. DRY/CC. WET MUD		0.525	0.393	0.603	0.664	0.636	0.619	0.629	0.477	0.611	0.655	0.584
G. IR/G. DRY MUD		1.40E-10	1.32E-09	1.04E-09	7.05E-10	3.77E-10	4.24E-10	2.43E-11	3.01E-10	2.24E-10	4.02E-10	3.50E-10
Σ DREDGE MATERIAL		0.000	5.160	3.728	1.994	0.313	0.554	0.000	0.000	0.000	0.442	0.174
SAMPLE B		3872	3830	3668	1367	1721	1940	2279	2672	2816	3338	3386
G. DRY/CC. WET MUD		0.520	0.519	0.560	0.740	0.584	0.512	0.567	0.604	0.524	0.552	0.562
G. IR/G. DRY MUD		7.88E-11	3.31E-09	1.51E-09	2.68E-10	1.84E-10	6.17E-10	2.70E-10	3.46E-10	-80L - 3.04E-11	3.21E-10	3.21E-10
Σ DREDGE MATERIAL		0.000	15.365	6.135	0.000	0.000	1.542	0.000	0.156	0.000	0.000	0.026
SAMPLE C		3873	3831	3669	1368	1722	1941	2279	2673	2817	3339	3387
G. DRY/CC. WET MUD		0.574	0.665	0.632	0.572	0.537	0.569	LOST	0.706	0.630	0.592	0.582
G. IR/G. DRY MUD		5.02E-10	-80L - 8.07E-10	4.62E-10	2.76E-10	7.60E-10	7.60E-10	SAMPLE	-80L - 7.84E-11	1.89E-11	2.32E-10	2.32E-10
Σ DREDGE MATERIAL		0.952	0.000	2.520	0.750	0.000	2.276	0.000	0.000	0.000	0.000	0.000
SAMPLE D					4248		4250					
G. DRY/CC. WET MUD					0.697		0.573					
G. IR/G. DRY MUD					4.99E-10		3.55E-10					
Σ DREDGE MATERIAL					0.940		0.199					
SAMPLE E					4249		4251					
G. DRY/CC. WET MUD					0.610		0.758					
G. IR/G. DRY MUD					3.20E-10		4.86E-10					
Σ DREDGE MATERIAL					0.020		0.875					
SAMPLE F												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE NO.		LOCATION		SAN PABLO BAY FLATS (STAKED)									
G	F	7	5	33											
SAMPLING DATES		13MAR74	26MAR74	11APR74	3MAY74	10JUN74	23JUL74	2AUG74	16SEP74	20CT74	22NOV74	12DEC74			
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.0	4.0	4.0	5.0	4.5	4.5	5.5	5.5	5.5	5.0	6.0			
THICKNESS OF LAYERS (IN)		2.5	0.2	1.5	1.0	2.5	0.5	3.0	0.0	0.0	0.0	2.0			
FLUFF		16.0	10.0	11.0	5.0	6.0	6.0	5.0	13.0	6.0	2.0	12.0			
ACTIVE		0.0	14.0	11.0	12.0	8.0	8.0	10.0	8.0	8.0	22.0	6.0			
INACTIVE															
SAMPLE A		1024	3802	3679	1435	1714	2032	2191	2674	2770	3325	3472			
G. DRY/CC WET MUD		1.144	0.520	0.587	0.582	0.514	0.484	0.493	0.581	0.630	0.600	0.555			
G. IR/G DRY MUD		7.08E-09	9.08E-10	9.83E-10	3.74E-10	3.28E-10	5.72E-10	6.71E-10	5.09E-11	1.65E-10	1.89E-10	2.05E-10			
DREDGE MATERIAL		34.668	3.035	3.421	0.297	0.063	1.311	1.821	0.000	0.000	0.000	0.000			
SAMPLE B		4673	3803	3680	1436	1715	2033	2192	2675	2771	3326	3473			
G. DRY/CC WET MUD		0.565	0.513	0.615	0.568	0.541	0.554	0.592	0.564	0.571	0.622	0.523			
G. IR/G DRY MUD		9.00E-11	1.64E-09	1.62E-09	6.83E-10	3.61E-10	2.86E-10	6.28E-10	2.55E-10	3.54E-10	5.89E-10	2.09E-10			
DREDGE MATERIAL		0.000	6.817	6.705	1.883	0.231	0.000	1.600	0.000	0.193	1.400	0.000			
SAMPLE C		4674	3804	3681	1437	1716	2034	2193	2676	2772	3327	3474			
G. DRY/CC WET MUD		0.551	0.657	0.662	0.508	0.592	0.627	0.552	0.524	0.543	0.602	0.520			
G. IR/G DRY MUD		5.62E-11	3.77E-10	6.30E-10	4.34E-10	2.56E-10	5.15E-11	2.79E-11	2.66E-10	5.06E-10	2.14E-10	3.87E-11			
DREDGE MATERIAL		0.000	0.313	1.609	0.605	0.000	0.000	0.000	0.000	0.973	0.000	0.000			
SAMPLE D		4675								4627					
G. DRY/CC WET MUD		0.672								0.672					
G. IR/G DRY MUD		3.04E-10								7.30E-10					
DREDGE MATERIAL		0.000								2.124					
SAMPLE E		4347													
G. DRY/CC WET MUD		0.726													
G. IR/G DRY MUD		1.73E-10													
DREDGE MATERIAL		0.000													
SAMPLE F															
G. DRY/CC WET MUD															
G. IR/G DRY MUD															
DREDGE MATERIAL															
SAMPLE G															
G. DRY/CC WET MUD															
G. IR/G DRY MUD															
DREDGE MATERIAL															
SAMPLE H															
G. DRY/CC WET MUD															
G. IR/G DRY MUD															
DREDGE MATERIAL															

COORDINATES	HOLE NO.	LOCATION	NO.	34	SAN PABLO BAY FLATS (STAKED)	13MAR74	26MAR74	4APR74	24MAY74	10JUN74	23JUL74	15AUG74	16SEP74	20CT74	22NOV74	12DEC74
G H 7 B																
SAMPLING DATES																
DEPTH OF SEDIMENT BELOW MLLW (FT)						3.0	4.0	4.0	5.0	5.5	4.5	5.0	4.5	4.5	4.5	5.0
THICKNESS OF LAYERS (IN)						1.5	1.0	1.0	1.5	2.0	0.5	0.5	0.0	1.0	0.0	1.0
FLUFF						10.0	22.0	20.0	9.0	7.0	5.0	6.0	8.0	6.0	5.0	5.0
ACTIVE						11.0	0.0	0.0	10.0	6.0	10.0	9.0	10.0	8.0	20.0	20.0
INACTIVE																
SAMPLE A						1033	3805	3742	1570	1699	2035	2353	2716	2818	3301	3370
G.DRY/CC.WET MUD						1.017	0.648	0.494	0.594	0.684	0.606	0.861	0.514	0.548	0.583	0.521
G.IR/G.DRY MUD						9.50E-09	2.45E-09	8.39E-11	1.21E-10	4.31E-10	5.42E-10	4.00E-10	9.04E-11	2.57E-10	2.79E-10	6.80E-10
Σ DREDGE MATERIAL						47.097	10.929	0.000	0.000	0.592	1.161	0.430	0.000	0.000	0.000	1.869
SAMPLE B						1034	3806	3743	1571	1700	2036	2354	2717	2819	3302	3371
G.DRY/CC.WET MUD						0.655	0.549	0.567	0.534	0.524	0.500	0.589	0.612	0.530	0.613	0.554
G.IR/G.DRY MUD						5.51E-09	9.20E-10	3.96E-10	2.75E-10	3.10E-10	-BOL	3.32E-10	2.37E-10	3.48E-11	4.47E-10	6.11E-10
Σ DREDGE MATERIAL						26.623	3.098	0.412	0.000	0.000	0.000	0.083	0.000	0.000	0.673	1.512
SAMPLE C						1035	3807	3744	1572	1701	2037	2355	2718	2820	3303	3372
G.DRY/CC.WET MUD						0.521	0.539	0.596	0.558	0.549	0.536	0.546	0.657	0.470	0.654	0.517
G.IR/G.DRY MUD						7.39E-09	8.80E-10	5.13E-10	1.47E-10	6.24E-10	2.95E-10	1.02E-10	4.14E-11	7.40E-11	2.14E-10	3.27E-10
Σ DREDGE MATERIAL						36.263	2.890	1.010	0.000	1.579	0.000	0.000	0.000	0.000	0.000	0.057
SAMPLE D						4348			4628	4252						4817
G.DRY/CC.WET MUD						0.522			0.545	0.512						0.675
G.IR/G.DRY MUD						3.56E-10			6.81E-11	1.61E-10						1.35E-10
Σ DREDGE MATERIAL						0.205			0.000	0.000						0.000
SAMPLE E									4629	4253						
G.DRY/CC.WET MUD									0.598	0.758						
G.IR/G.DRY MUD									-BOL	2.00E-10						
Σ DREDGE MATERIAL									0.000	0.000						
SAMPLE F						4349										
G.DRY/CC.WET MUD						0.571										
G.IR/G.DRY MUD						5.36E-10										
Σ DREDGE MATERIAL						1.131										
SAMPLE G																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
Σ DREDGE MATERIAL																
SAMPLE H																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
Σ DREDGE MATERIAL																

COORDINATES			HOLE		LOCATION									
H	E	7 5	NO.	35	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES			13MAR74	26MAR74	4APR74	8MAY74	10JUN74	23JUL74	15AUG74	16SEP74	11OCT74	22NOV74	12DEC74	
DEPTH OF SEDIMENT BELOW MLW (FT)			-NA-	5.0	4.0	4.0	3.0	3.5	5.0	4.5	4.5	4.5	5.0	
THICKNESS OF LAYERS (IN)														
FLUFF			0.5	0.3	1.0	2.0	1.0	1.0	0.0	0.0	2.0	0.0	2.0	
ACTIVE			19.0	14.0	19.0	8.0	5.0	5.0	9.0	11.0	8.0	2.0	16.0	
INACTIVE			0.0	7.0	0.0	8.0	11.0	8.0	6.0	10.0	10.0	20.0	5.0	
SAMPLE A			1045	3886	3652	1351	1705	2038	2350	2677	2923	3238	3379	
G. DRY/CC.WET MUD			0.415	0.890	0.727	0.623	0.705	0.518	0.818	0.718	0.837	0.489	0.511	
G. IR/G.DRY MUD			5.70E-09	8.43E-12	1.42E-10	5.62E-10	4.82E-10	2.65E-10	4.48E-10	3.46E-10	1.93E-10	7.91E-10		
Σ DREDGE MATERIAL			27.588	0.000	0.000	1.264	0.852	0.000	0.000	0.679	0.155	0.000	2.434	
SAMPLE B			1047	3887	3653	1352	1706	2039	2351	2678	2924	3239	3380	
G. DRY/CC.WET MUD			0.599	0.539	0.705	0.615	0.650	0.638	0.596	0.579	0.603	0.783	0.727	
G. IR/G.DRY MUD			8.67E-09	1.45E-09	7.53E-12	5.77E-10	3.10E-10	-BOL-	2.02E-10	1.34E-10	-BOL-	1.58E-10	-BOL-	
Σ DREDGE MATERIAL			42.850	5.816	0.000	1.336	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SAMPLE C			1046	3888	3654	1353	1707	2040	2352	2679	2925	3240	3381	
G. DRY/CC.WET MUD			0.554	0.613	0.650	0.534	0.634	0.561	0.620	0.617	0.645	0.740	0.730	
G. IR/G.DRY MUD			9.47E-09	1.52E-09	6.18E-10	1.04E-09	4.56E-10	1.78E-10	7.88E-11	-BOL-	3.47E-10	1.33E-10	7.08E-10	
Σ DREDGE MATERIAL			46.971	6.178	1.547	3.692	0.717	0.000	0.000	0.000	0.160	0.000	2.009	
SAMPLE D			4350			4254	4256				4258		4750	
G. DRY/CC.WET MUD			0.569			0.510	0.675				0.633		0.511	
G. IR/G.DRY MUD			4.59E-10			-BOL-	-BOL-				-BOL-		4.73E-10	
Σ DREDGE MATERIAL			0.735			0.000	0.000				0.000		0.808	
SAMPLE E						4255	4257				4259		4751	
G. DRY/CC.WET MUD						0.566	0.633				0.548		0.638	
G. IR/G.DRY MUD						4.87E-10	1.56E-10				2.38E-11		8.91E-10	
Σ DREDGE MATERIAL						0.875	0.000				0.000		2.949	
SAMPLE F			4351											
G. DRY/CC.WET MUD			0.595											
G. IR/G.DRY MUD			1.14E-10											
Σ DREDGE MATERIAL			0.000											
SAMPLE G														
G. DRY/CC.WET MUD														
G. IR/G.DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H														
G. DRY/CC.WET MUD														
G. IR/G.DRY MUD														
Σ DREDGE MATERIAL														

COORDINATES		HOLE NO.	LOCATION									
G C 7 8	36	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES		13MAR74	26MAR74	4APR74	3MAY74	10JUN74	19JUL74	2AUG74	16SEP74	20CT74	22NOV74	12DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		3.0	4.0	4.5	4.5	5.0	4.5	5.5	4.5	5.0	5.0	5.0
THICKNESS OF LAYERS (IN)												
FLUFF	1.5	0.2	1.5	2.0	2.0	1.0	2.0	0.0	0.0	1.0	0.0	2.0
ACTIVE	7.0	12.0	13.0	3.0	7.0	7.0	7.0	7.0	11.0	6.0	2.0	8.0
INACTIVE	12.0	12.0	7.0	14.0	11.0	13.0	14.0	6.0	11.0	22.0	14.0	14.0
SAMPLE A	3868	3832	3745	1429	1702	1969	2266	2680	2821	3241	3367	
G.DRY/CC.WET MUD	0.609	0.437	0.649	0.611	0.538	0.746	0.587	0.560	0.707	0.486	0.562	
G.IR/G.DRY MUD	1.32E-09	8.68E-10	6.38E-10	8.40E-11	3.10E-11	8.93E-10	-BOL- 2.84E-10	4.06E-10	3.43E-10	-BOL-	-BOL-	
* DREDGE MATERIAL	5.155	2.831	1.652	2.687	0.000	2.958	0.000	0.000	0.464	0.141	0.000	
SAMPLE B	3869	3833	3746	1430	1703	1970	2267	2681	2822	3242	3368	
G.DRY/CC.WET MUD	0.511	0.528	0.516	0.575	0.595	0.539	0.628	0.576	0.576	0.560	0.462	
G.IR/G.DRY MUD	1.02E-10	1.15E-09	5.01E-10	5.28E-10	3.99E-10	7.32E-10	-BOL- 4.06E-10	1.32E-10	2.16E-10	5.57E-10	5.57E-10	
* DREDGE MATERIAL	0.000	4.337	0.949	1.089	0.426	2.135	0.000	0.461	0.000	0.000	1.235	
SAMPLE C	3870	3834	3747	1431	1704	1971	2268	2682	2823	3243	3369	
G.DRY/CC.WET MUD	0.597	0.557	0.678	0.532	0.543	0.531	0.540	0.622	0.610	0.030	0.574	
G.IR/G.DRY MUD	2.21E-09	6.56E-10	3.64E-10	3.30E-10	4.80E-10	9.02E-10	-BOL-	-BOL-	-BOL-	1.00E-09	4.49E-10	
* DREDGE MATERIAL	9.715	1.743	0.246	0.071	0.844	3.007	0.000	0.000	0.000	3.527	0.684	
SAMPLE D												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												
SAMPLE E												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												
SAMPLE F												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												
SAMPLE G												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												
4753												
0.673												
8.44E-12												
0.000												
4755												
0.697												
3.23E-10												
0.034												
4752												
0.620												
5.48E-11												
2.49E-10												
0.000												
0.000												
4754												
0.620												
5.48E-11												
2.49E-10												
0.000												
0.000												
4755												
0.697												
3.23E-10												
0.034												

4753  
0.673  
8.44E-12  
0.000

4263  
0.438  
2.23E-10  
0.000

4261  
0.576  
4.59E-10  
0.736

4260  
0.547  
8.73E-11  
0.000

COORDINATES		HOLE NO.		LOCATION											
D	C	11	B	37	CARQUINEZ STRAIT (STAKED)										
SAMPLING DATES		15MAR74	29MAR74	16APR74	24MAY74	17JUN74	30JUL74	13AUG74	13SEP74	10OCT74	14NOV74	12DEC74			
DEPTH OF SEDIMENT BELOW MLW (FT)		1.0	2.0	1.5	1.0	1.0	0.5	1.5	2.0	1.5	1.5	1.5			
THICKNESS OF LAYERS (IN)		0.3	0.4	1.5	1.0	2.0	0.0	1.0	0.0	2.0	0.0	1.0			
FLUFF		5.0	10.0	11.0	9.0	7.0	8.0	7.0	9.0	8.0	12.0	6.0			
ACTIVE		12.0	10.0	11.0	6.0	8.0	8.0	10.0	9.0	9.0	14.0	16.0			
SAMPLE A		1027	3895	1153	1516	1795	2158	2326	2644	2872	3187	3649			
G.DRY/CC.WET MUD		0.462	0.691	0.458	0.754	0.716	0.671	1.025	0.905	0.894	0.628	0.554			
G.IR/G.DRY MUD		3.27E-09	3.76E-12	9.22E-10	2.95E-10	3.67E-10	2.91E-10	2.16E-10	6.23E-10	2.64E-10	1.16E-10	-BOL-			
Σ DREDGE MATERIAL		15.158	0.000	3.107	0.000	0.263	0.000	0.000	1.576	0.000	0.000	0.000			
SAMPLE B		1029	3896	1154	1517	1796	2159	2327	2645	2873	3188	3650			
G.DRY/CC.WET MUD		0.641	0.584	0.647	0.693	0.603	0.587	0.697	0.544	1.032	0.655	0.500			
G.IR/G.DRY MUD		5.09E-09	-BOL-	6.50E-10	3.23E-10	4.54E-10	1.88E-10	4.06E-10	4.42E-10	1.07E-10	8.56E-10	2.75E-10			
Σ DREDGE MATERIAL		24.491	0.000	1.713	0.038	0.709	0.000	0.464	0.647	0.000	2.770	0.000			
SAMPLE C		1028	3897	1155	1518	1797	2160	2328	2646	2874	3189	3651			
G.DRY/CC.WET MUD		0.640	0.600	0.485	0.487	0.582	0.746	0.536	0.534	0.922	0.602	0.577			
G.IR/G.DRY MUD		6.53E-09	1.77E-10	1.72E-09	5.32E-10	1.16E-10	1.57E-10	9.98E-10	3.48E-10	6.78E-11	-BOL-	7.22E-12			
Σ DREDGE MATERIAL		31.853	0.000	7.177	1.110	0.000	0.000	3.500	0.165	0.000	0.000	0.000			
SAMPLE D		4352	4264	4265	4266	4267	4268	4269	4270	4271	4272	4273			
G.DRY/CC.WET MUD		0.623	0.576	0.576	0.540	0.541	0.558	0.558	0.541	0.541	0.541	0.541			
G.IR/G.DRY MUD		4.34E-10	2.80E-10	2.76E-11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Σ DREDGE MATERIAL		0.608	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
SAMPLE E		4353	4265	4266	4267	4268	4269	4270	4271	4272	4273	4274			
G.DRY/CC.WET MUD		0.606	0.557	0.557	0.540	0.541	0.541	0.541	0.541	0.541	0.541	0.541			
G.IR/G.DRY MUD		4.48E-12	1.29E-10	2.99E-10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
SAMPLE F		4354	4266	4267	4268	4269	4270	4271	4272	4273	4274	4275			
G.DRY/CC.WET MUD		0.606	0.557	0.557	0.540	0.541	0.541	0.541	0.541	0.541	0.541	0.541			
G.IR/G.DRY MUD		4.48E-12	1.29E-10	2.99E-10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
SAMPLE G		4355	4267	4268	4269	4270	4271	4272	4273	4274	4275	4276			
G.DRY/CC.WET MUD		0.606	0.557	0.557	0.540	0.541	0.541	0.541	0.541	0.541	0.541	0.541			
G.IR/G.DRY MUD		4.48E-12	1.29E-10	2.99E-10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
SAMPLE H		4356	4268	4269	4270	4271	4272	4273	4274	4275	4276	4277			
G.DRY/CC.WET MUD		0.606	0.557	0.557	0.540	0.541	0.541	0.541	0.541	0.541	0.541	0.541			
G.IR/G.DRY MUD		4.48E-12	1.29E-10	2.99E-10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

COORDINATES		HOLE NO.	LOCATION									
C H 11 B		38	CARQUINEZ STRAIT									
SAMPLING DATES		15MAR74	29MAR74	23APR74	9MAY74	17JUN74	29JUL74	28AUG74	13SEP74	15OCT74	13NOV74	12DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)		45.0	44.0	44.0	44.0	43.0	43.0	43.0	43.0	43.0	43.5	43.0
THICKNESS OF LAYERS (IN)												
FLUFF		0.3	-NA-	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0
ACTIVE		16.0	-NA-	5.0	5.0	9.0	5.0	5.0	5.0	8.0	6.0	2.0
INACTIVE		0.0	-NA-	16.0	12.0	6.0	4.0	12.0	16.0	15.0	20.0	26.0
SAMPLE A		1007	3907									
G.DRY/CC.WET MUD		0.379	0.773	LOST	0.764	0.989	0.658	0.780	1.015	0.519	0.622	0.742
G.IR/G.DRY MUD		2.26E-08	2.01E-10	SAMPLE	6.05E-10	2.35E-10	-BOL-	1.31E-10	9.03E-11	9.25E-10	-BOL-	1.94E-09
Σ DREDGE MATERIAL		114.230	0.000	1.481	1.481	0.000	0.000	0.000	0.000	3.124	0.000	8.344
SAMPLE B		4660	3908	4854	1412	1826	2183	2462	2648	3008	3209	3401
G.DRY/CC.WET MUD		0.767	0.586	0.478	0.716	0.825	0.762	0.688	0.901	0.554	0.814	0.601
G.IR/G.DRY MUD		2.91E-10	3.86E-11	6.64E-11	5.55E-10	2.67E-10	1.89E-10	-BOL-	-BOL-	9.92E-10	6.59E-11	3.86E-10
Σ DREDGE MATERIAL		0.000	0.000	1.784	1.224	0.000	0.000	0.000	0.000	3.465	0.000	0.357
SAMPLE C		4661	3909	4855	1413	1827	2184	2463	2649	3009	3210	3402
G.DRY/CC.WET MUD		0.802	0.629	0.543	0.749	0.801	0.892	0.748	0.788	0.652	0.775	0.634
G.IR/G.DRY MUD		1.29E-10	8.58E-12	5.86E-10	1.43E-09	4.13E-10	5.41E-10	5.14E-10	3.01E-11	-BOL-	3.85E-11	3.09E-10
Σ DREDGE MATERIAL		0.000	0.000	1.393	5.694	0.498	1.153	1.015	0.000	0.000	0.000	0.000
SAMPLE D		4662	4869	4851	4272	4274	4276	4278				
G.DRY/CC.WET MUD		0.810	0.526	0.732	0.737	0.640	0.724	0.699				
G.IR/G.DRY MUD		-BOL-	-BOL-	1.99E-10	5.99E-10	6.61E-10	9.73E-10	1.36E-09				
Σ DREDGE MATERIAL		0.000	0.000	0.000	1.449	1.768	3.371	5.344				
SAMPLE E		4663	4870	4852	4273	4275	4277	4279				
G.DRY/CC.WET MUD		0.789	0.538	0.527	0.747	0.730	0.685	0.623				
G.IR/G.DRY MUD		-BOL-	1.28E-10	5.47E-11	2.28E-09	5.15E-10	7.58E-10	7.83E-10				
Σ DREDGE MATERIAL		0.000	0.000	0.000	10.082	1.023	2.259	2.395				
SAMPLE F		4664	4871	4853								
G.DRY/CC.WET MUD		0.679	0.538	0.543								
G.IR/G.DRY MUD		-BOL-	3.41E-10	1.13E-10								
Σ DREDGE MATERIAL		0.000	0.129	0.000								
SAMPLE G		4665	4872									
G.DRY/CC.WET MUD		0.681	0.535									
G.IR/G.DRY MUD		1.60E-10	4.03E-10									
Σ DREDGE MATERIAL		0.000	0.447									
SAMPLE H		4666										
G.DRY/CC.WET MUD		0.864										
G.IR/G.DRY MUD		3.57E-12										
Σ DREDGE MATERIAL		0.000										

COORDINATES	HOLE NO.	LOCATION										
B E II 8	39	CARQUINEZ STRAIT										
SAMPLING DATES	15MAR74	29MAR74	23APR74	9MAY74	17JUN74	29JUL74	28AUG74	13SEP74	15OCT74	13NOV74	12DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	42.0	42.0	42.0	42.0	42.0	41.0	41.0	42.0	41.0	41.0	41.5	
THICKNESS OF FLUFF LAYERS (IN)	0.0	0.3	0.0	1.0	2.0	0.0	0.0	1.0	2.0	0.0	1.0	
ACTIVE	11.0	7.0	9.0	8.0	9.0	10.0	6.0	5.0	8.0	3.0	3.0	
INACTIVE	0.0	12.0	13.0	12.0	10.0	11.0	9.0	9.0	12.0	20.0	19.0	
SAMPLE A	1057	3910	1249	1396	1789	2107	2464	2650	2977	3178	3571	
G.DRY/CC.WET MUD	0.378	0.601	0.532	0.720	0.675	0.763	0.730	0.648	0.505	0.505	0.570	
G.1R/G.DRY MUD	4.38E-09	1.51E-10	8.14E-10	3.69E-10	6.28E-10	1.23E-10	3.64E-10	4.18E-10	4.61E-10	4.61E-10	8.36E-11	
Σ DREDGE MATERIAL	20.835	0.000	2.554	0.273	1.601	0.000	0.248	0.759	0.525	0.745	0.000	
SAMPLE B	1059	3911	1250	1397	1790	2108	2465	2651	2978	3179	3572	
G.DRY/CC.WET MUD	0.652	0.539	0.609	0.632	0.554	0.639	0.592	0.509	0.614	0.410	0.488	
G.1R/G.DRY MUD	3.85E-09	-BOL	9.28E-10	5.67E-10	2.08E-10	1.54E-10	1.73E-10	2.08E-10	6.76E-10	4.38E-10	1.06E-10	
Σ DREDGE MATERIAL	18.125	0.000	3.137	1.289	0.000	0.000	0.000	0.000	1.845	0.624	0.000	
SAMPLE C	1058	3912	1251	1398	1791	2109	2466	2652	2979	3180	3573	
G.DRY/CC.WET MUD	0.586	0.633	0.639	0.607	0.542	0.622	0.576	0.619	0.657	0.432	0.576	
G.1R/G.DRY MUD	4.04E-09	3.03E-10	6.16E-10	5.94E-10	1.96E-10	3.36E-11	2.56E-10	4.03E-10	1.33E-10	3.77E-10	-BOL	
Σ DREDGE MATERIAL	19.116	0.000	1.540	1.426	0.000	0.000	0.000	0.444	0.000	0.313	0.000	
SAMPLE D	4632	4867	4280	4282				4284	4634	4819		
G.DRY/CC.WET MUD	0.520	0.561	0.655	0.589				0.596	0.641	0.520		
G.1R/G.DRY MUD	1.77E-10	3.08E-10	5.63E-10	3.57E-10				1.45E-10	6.99E-11	2.27E-10		
Σ DREDGE MATERIAL	0.000	0.000	1.269	0.210				0.000	0.000	0.000		
SAMPLE E	4633			4283								
G.DRY/CC.WET MUD	0.617			0.610								
G.1R/G.DRY MUD	8.85E-11			2.41E-10								
Σ DREDGE MATERIAL	0.000			0.000								
SAMPLE F												
G.DRY/CC.WET MUD												
G.1R/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G		4868	4281					4285	4635	4820		
G.DRY/CC.WET MUD		0.647	0.553					0.657	0.729	0.588		
G.1R/G.DRY MUD		4.42E-10	6.80E-10					1.15E-10	-BOL	-BOL		
Σ DREDGE MATERIAL		0.647	1.865					0.000	0.000	0.000		
SAMPLE H												
G.DRY/CC.WET MUD												
G.1R/G.DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION									
A F 12 6		40	CARQUINEZ STRAIT									
SAMPLING DATES		15MAR74	28MAR74	16APR74	16MAY74	11JUN74	30JUL74	13AUG74	11SEP74	10OCT74	14NOV74	11DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)		0.0	1.0	1.0	1.0	1.5	1.0	1.5	2.0	1.5	8.0	8.0
THICKNESS OF LAYERS (IN)												
FLUFF		0.2	0.4	2.5	1.5	1.0	1.0	1.0	1.0	1.5	0.0	0.0
ACTIVE		17.0	9.0	8.0	9.0	15.0	14.0	14.0	7.0	8.0	11.0	5.0
INACTIVE		0.0	8.0	8.0	10.0	3.0	6.0	6.0	6.0	9.0	16.0	16.0
SAMPLE A		1021	3904	1129	1426	1717	2122	2329	2572	2902	3226	3430
G.DRY/CC.WET MUD		0.584	0.730	0.444	0.638	0.588	0.576	0.755	0.582	0.591	0.289	0.432
G.IR/G.DRY MUD		7.45E-09	4.14E-10	1.08E-09	3.57E-10	3.59E-10	1.93E-10	2.25E-10	9.83E-11	6.68E-10	2.10E-11	8.87E-10
Σ DREDGE MATERIAL		36.569	0.503	3.905	0.213	0.219	0.000	0.000	0.000	1.806	0.000	2.930
SAMPLE B		1022	3905	1130	1427	1718	2123	2330	2573	2903	3227	3431
G.DRY/CC.WET MUD		0.630	0.565	0.566	0.604	0.573	0.586	0.612	0.629	0.708	0.490	0.347
G.IR/G.DRY MUD		6.50E-09	-BOL-	2.22E-09	7.06E-10	3.07E-10	2.46E-10	3.43E-10	3.53E-10	3.43E-09	2.51E-10	1.75E-09
Σ DREDGE MATERIAL		31.740	0.000	9.753	2.001	0.000	0.000	0.139	0.190	15.983	0.000	7.359
SAMPLE C		1023	3906	1131	1428	1719	2124	2331	2574	2904	3228	3432
G.DRY/CC.WET MUD		0.642	0.654	0.558	0.551	0.593	0.545	0.632	0.635	0.723	0.578	0.418
G.IR/G.DRY MUD		1.30E-08	2.23E-10	1.21E-09	7.27E-10	5.93E-10	1.37E-10	4.38E-10	5.32E-10	1.03E-09	-BOL-	2.05E-10
Σ DREDGE MATERIAL		64.840	0.000	4.585	2.110	1.423	0.000	0.625	1.108	3.670	0.000	0.000
SAMPLE D		4356	4529	4286	4288	4290	4290	4292	4294	4295	4756	4758
G.DRY/CC.WET MUD		0.616	0.552	0.539	0.641	0.583	0.583	0.601	0.641	0.541	0.506	0.434
G.IR/G.DRY MUD		3.76E-11	-BOL-	4.82E-11	7.04E-11	6.18E-10	5.91E-10	2.22E-10	2.97E-10	3.48E-10	2.72E-10	0.000
Σ DREDGE MATERIAL		0.000	0.000	0.852	0.000	1.551	1.410	0.000	0.000	0.000	0.164	0.000
SAMPLE E		4357	4289	4289	4289	4291	4291	4293	4294	4296	4757	4759
G.DRY/CC.WET MUD		0.577	0.603	0.603	0.603	0.629	0.629	0.709	0.641	0.642	0.525	0.520
G.IR/G.DRY MUD		3.64E-10	9.63E-11	2.22E-10	9.63E-11	2.22E-10	2.22E-10	2.33E-10	2.97E-10	4.47E-10	4.37E-10	1.71E-10
Σ DREDGE MATERIAL		0.245	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.670	0.622	0.000
SAMPLE F		4530	4287	4287	4287	4287	4287	4287	4287	4287	4287	4287
G.DRY/CC.WET MUD		0.615	0.572	0.572	0.572	0.572	0.572	0.572	0.572	0.572	0.572	0.572
G.IR/G.DRY MUD		3.51E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10	2.56E-10
Σ DREDGE MATERIAL		0.178	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE G		4531	4288	4288	4288	4288	4288	4288	4288	4288	4288	4288
G.DRY/CC.WET MUD		0.616	0.577	0.577	0.577	0.577	0.577	0.577	0.577	0.577	0.577	0.577
G.IR/G.DRY MUD		3.76E-11	-BOL-	4.82E-11	7.04E-11	6.18E-10	5.91E-10	2.22E-10	2.97E-10	3.48E-10	2.72E-10	0.000
Σ DREDGE MATERIAL		0.000	0.000	0.852	0.000	1.551	1.410	0.000	0.000	0.000	0.164	0.000
SAMPLE H		4532	4289	4289	4289	4289	4289	4289	4289	4289	4289	4289
G.DRY/CC.WET MUD		0.616	0.577	0.577	0.577	0.577	0.577	0.577	0.577	0.577	0.577	0.577
G.IR/G.DRY MUD		3.76E-11	-BOL-	4.82E-11	7.04E-11	6.18E-10	5.91E-10	2.22E-10	2.97E-10	3.48E-10	2.72E-10	0.000
Σ DREDGE MATERIAL		0.000	0.000	0.852	0.000	1.551	1.410	0.000	0.000	0.000	0.164	0.000

COORDINATES			HOLE NO.	LOCATION										
B C 12 8			41	CARGUINEZ STRAIT (STAKED)										
SAMPLING DATES			15MAR74	28MAR74	16APR74	16MAY74	11JUN74	30JUL74	13AUG74	11SEP74	10OCT74	14NOV74	11DEC74	
DEPTH OF SEDIMENT BELOW MLW (FT)			2.0	2.0	2.0	2.0	3.0	2.5	3.0	3.0	2.5	2.5	2.5	
THICKNESS OF LAYERS (IN)														
FLUFF			0.0	0.1	0.5	2.0	0.5	1.0	0.0	0.0	2.0	0.0	0.0	
ACTIVE			20.0	13.0	10.0	5.0	4.0	7.0	13.0	9.0	6.0	4.0	5.0	
INACTIVE			0.0	6.0	6.0	10.0	16.0	11.0	8.0	8.0	10.0	12.0	16.0	
SAMPLE A			1039	3883	1162	1450	1777	2125	2332	2575	2875	3229	3460	
G. DRY/CC. WET MUD			0.346	0.682	0.676	0.571	0.614	0.832	0.843	0.805	0.547	0.661	0.688	
G. IR/G. DRY MUD			3.47E-09	-BOL -	1.02E-09	5.64E-10	2.60E-10	1.69E-11	9.83E-11	6.16E-10	4.80E-10	2.61E-10	-BOL -	
Σ DREDGE MATERIAL			16.196	0.000	3.637	1.274	0.000	0.000	0.000	1.540	0.839	0.000	0.000	
SAMPLE B			1040	3884	1163	1451	1778	2126	2333	2576	2876	3230	3461	
G. DRY/CC. WET MUD			0.725	0.590	0.589	0.631	0.520	0.673	0.571	0.613	0.530	0.587	0.687	
G. IR/G. DRY MUD			3.18E-09	-BOL -	1.44E-09	5.11E-10	3.49E-10	1.50E-10	2.79E-10	2.95E-10	4.84E-10	1.27E-10	4.85E-10	
Σ DREDGE MATERIAL			14.686	0.000	5.754	1.001	0.171	0.000	0.000	0.000	0.860	0.000	0.866	
SAMPLE C			1041	3885	1164	1452	1779	2127	2334	2577	2877	3231	3462	
G. DRY/CC. WET MUD			0.691	0.714	0.598	0.585	0.521	0.721	0.626	0.632	0.570	0.822	0.552	
G. IR/G. DRY MUD			5.15E-09	1.91E-10	7.54E-10	6.46E-10	3.92E-10	4.63E-10	1.88E-10	1.73E-10	-BOL -	1.35E-10	-BOL -	
Σ DREDGE MATERIAL			24.793	0.000	2.249	1.690	0.389	0.755	0.000	0.000	0.000	0.000	0.000	
SAMPLE D			4358	4881		4297	4137	4636			4299			
G. DRY/CC. WET MUD			0.627	0.608		0.523	0.533	0.588			0.627			
G. IR/G. DRY MUD			-BOL -	2.73E-11		4.91E-10	2.26E-10	4.66E-11			3.28E-10			
Σ DREDGE MATERIAL			0.000	0.000		0.895	0.000	0.000			0.063			
SAMPLE E				4882		4298	4138	4637			4300			
G. DRY/CC. WET MUD				0.611		0.524	0.587	0.656			0.643			
G. IR/G. DRY MUD				3.37E-10		2.91E-10	2.52E-10	2.91E-10			2.87E-10			
Σ DREDGE MATERIAL				0.109		0.000	0.000	0.000			0.000			
SAMPLE F				4359										
G. DRY/CC. WET MUD				0.516										
G. IR/G. DRY MUD				6.06E-10										
Σ DREDGE MATERIAL				1.489										
SAMPLE G														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														

COORDINATES		HOLE LOCATION											
F	C	7	3	NO.	42	PINOLE SHOAL							
SAMPLING DATES				22MAR74	3APR74	13MAY74	4JUN74	11JUL74	5AUG74	30SEP74	9OCT74	6NOV74	4DEC74
DEPTH OF SEDIMENT BELOW MLW (FT.)				28.0	28.0	27.5	27.0	27.0	26.0	26.0	27.0	26.5	26.5
THICKNESS OF LAYERS (IN)				0.2	0.1	1.5	1.5	4.0	0.0	0.0	2.0	0.0	0.0
FLUFF				19.0	14.0	9.0	7.5	7.0	7.0	7.0	6.0	7.0	4.0
ACTIVE				0.0	14.0	12.0	8.0	8.0	16.0	12.0	12.0	11.0	17.0
INACTIVE													
SAMPLE A				3850	3925	1444	1585	1948	2272	2758	2896	3151	3508
G.DRY/CC.WET MUD				0.492	0.847	0.671	0.836	0.915	0.824	1.039	0.617	0.731	1.057
G.IR/G.DRY MUD				1.72E-10	1.17E-10	5.12E-10	2.21E-10	4.66E-10	3.03E-10	9.01E-11	1.85E-11	1.79E-11	1.29E-10
Σ DREDGE MATERIAL				0.000	0.000	1.008	0.000	0.768	0.000	0.000	0.000	0.000	0.000
SAMPLE B				3851	3926	1445	1586	1949	2273	2759	2897	3152	3509
G.DRY/CC.WET MUD				0.783	0.847	0.545	1.081	0.762	0.638	1.026	0.509	1.006	0.650
G.IR/G.DRY MUD				6.49E-11	1.76E-10	3.06E-10	2.00E-10	6.00E-10	7.26E-11	3.69E-10	9.82E-11	1.97E-10	1.77E-10
Σ DREDGE MATERIAL				0.000	0.000	0.000	0.000	1.457	0.000	0.272	0.000	0.000	0.000
SAMPLE C				3852	3927	1446	1587	1950	2274	2760	2898	3153	3510
G.DRY/CC.WET MUD				0.686	1.017	0.614	1.205	0.594	0.571	0.666	0.568	0.825	0.560
G.IR/G.DRY MUD				2.93E-09	-BOL -	4.15E-10	4.78E-10	1.02E-09	2.99E-10	4.73E-10	4.96E-09	4.16E-10	4.40E-10
Σ DREDGE MATERIAL				13.427	0.000	0.510	0.832	3.624	0.000	0.803	23.815	0.512	0.637
SAMPLE D													
G.DRY/CC.WET MUD										4303	4305	4823	4821
G.IR/G.DRY MUD										0.687	0.555	0.999	0.827
Σ DREDGE MATERIAL										-BOL -	2.41E-10	1.00E-10	3.54E-10
SAMPLE E										0.000	0.000	0.000	0.193
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE F													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE G													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													

COORDINATES			HOLE NO.		LOCATION										
E	F	5	6	43	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES		20MAR74	3APR74	3MAY74	24JUL74	2AUG74	3SEP74	17OCT74	23NOV74	13DEC74					
DEPTH OF SEDIMENT BELOW MLLW (FT)		6.5	7.0	6.0	8.0	5.0	7.0	6.0	6.5	7.0					
THICKNESS OF LAYERS (IN)															
FLUFF		0.2	0.3	1.0	1.5	1.5	2.0	2.0	1.0	1.0					
ACTIVE		7.0	8.0	5.0	6.5	7.0	8.0	7.0	3.0	6.0					
INACTIVE		11.0	11.0	7.0	9.0	6.0	13.0	15.0	20.0	17.0					
SAMPLE A		3727	3772	1408	1594	2047	2245	2506	3256	3433					
G.DRY/CC.WET MUD		0.558	0.445	0.590	0.787	0.581	0.593	0.655	0.578	0.540					
G.IR/G.DRY MUD		5.45E-10	2.39E-10	6.80E-10	2.53E-10	4.66E-10	~80L	3.01E-10	5.79E-10	6.78E-10					
X DREDGE MATERIAL		1.177	0.000	1.868	0.000	0.772	0.000	0.000	1.348	1.859					
SAMPLE B		3728	3773	1409	1595	2048	2246	2507	3257	3434					
G.DRY/CC.WET MUD		0.556	0.536	0.716	0.766	0.752	0.700	0.675	0.637	0.568					
G.IR/G.DRY MUD		7.46E-10	8.75E-11	6.25E-10	8.46E-10	1.84E-10	5.87E-11	5.55E-11	6.80E-11	6.78E-10					
X DREDGE MATERIAL		2.203	0.000	1.583	2.718	0.000	0.000	0.000	0.000	1.859					
SAMPLE C		3729	3774	1410	1596	2049	2247	2508	3258	3435					
G.DRY/CC.WET MUD		0.703	0.769	0.491	0.693	0.878	0.731	0.730	0.811	0.734					
G.IR/G.DRY MUD		4.20E-10	8.92E-11	4.22E-10	3.42E-10	2.22E-10	3.35E-10	8.15E-11	1.68E-10	3.98E-10					
X DREDGE MATERIAL		0.533	0.000	0.542	0.133	0.000	0.101	0.000	28.779	0.420					
SAMPLE D				4307	4309		4311			4825					
G.DRY/CC.WET MUD				0.660	0.675		0.678			0.611					
G.IR/G.DRY MUD				1.81E-10	4.99E-10		3.35E-10			1.09E-10					
X DREDGE MATERIAL				0.000	0.941		0.096			0.000					
SAMPLE E				4308	4310										
G.DRY/CC.WET MUD				0.652	0.709										
G.IR/G.DRY MUD				3.93E-10	1.90E-10										
X DREDGE MATERIAL				0.397	0.000										
SAMPLE F							4312			4826					
G.DRY/CC.WET MUD							0.718			0.688					
G.IR/G.DRY MUD							2.61E-11			1.73E-10					
X DREDGE MATERIAL							0.000			0.000					
SAMPLE G															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
X DREDGE MATERIAL															
SAMPLE H															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
X DREDGE MATERIAL															

COORDINATES	HOLE NO.	LOCATION
E C 4 B	44	SAN PABLO BAY FLATS
SAMPLING DATES	20MAR74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	2.0	
THICKNESS OF LAYERS (IN)	0.3	
FLUFF	5.0	
ACTIVE	15.0	
INACTIVE		
SAMPLE A	3730	
G.DRY/CC.WET MUD	0.486	
G.1R/G.DRY MUD	4.54E-10	
* DREDGE MATERIAL	0.709	
SAMPLE B	3731	
G.DRY/CC.WET MUD	0.553	
G.1R/G.DRY MUD	6.81E-10	
* DREDGE MATERIAL	1.873	
SAMPLE C	3732	
G.DRY/CC.WET MUD	0.653	
G.1R/G.DRY MUD	3.15E-10	
* DREDGE MATERIAL	0.000	
SAMPLE D		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE E		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE F		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE G		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE H		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		

COORDINATES				HOLE		LOCATION										
E	F	4	5	NO.	45	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES						20MAR74	3APR74	15MAY74	3JUN74	24JUL74	2AUG74	3SEP74	17OCT74	23NOV74	13DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)						3.0	3.0	3.0	3.5	5.0	2.5	4.0	4.5	3.5	3.5	3.5
THICKNESS OF LAYERS (IN)																
FLUFF						0.3	0.4	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0
ACTIVE						3.0	9.0	7.0	9.0	1.0	1.0	7.0	7.0	5.0	2.0	6.0
INACTIVE						16.0	6.0	11.0	8.0	18.0	18.0	14.0	11.0	21.0	24.0	17.0
SAMPLE A						3814	3775	1474	1615	2050	2227	2473	3046	3331	3637	
G.DRY/CC.WET MUD						0.778	0.430	0.498	0.635	0.643	0.584	0.683	0.370	0.424	0.421	
G.IR/G.DRY MUD						3.78E-09	4.81E-10	3.42E-10	2.89E-10	1.03E-10	5.51E-10	1.47E-10	1.77E-09	-BDL-	-BDL-	
X DREDGE MATERIAL						17.746	0.847	0.133	0.000	0.000	1.204	0.000	7.473	0.000	0.000	
SAMPLE B						3815	3776	1475	1616	2051	2228	2474	3047	3332	3638	
G.DRY/CC.WET MUD						0.514	0.672	0.617	0.625	0.582	0.615	0.616	0.601	0.568	0.602	
G.IR/G.DRY MUD						-BDL-	2.28E-10	3.07E-10	1.21E-09	4.61E-10	5.64E-11	-BDL-	-BDL-	2.66E-10	4.31E-12	
X DREDGE MATERIAL						0.000	0.000	0.000	4.574	0.743	0.000	0.000	0.000	0.000	0.000	
SAMPLE C						3816	3777	1476	1617	2052	2229	2475	3048	3333	3639	
G.DRY/CC.WET MUD						0.696	0.769	0.649	0.638	0.666	0.627	0.625	0.637	0.591	0.583	
G.IR/G.DRY MUD						-BDL-	4.03E-10	7.34E-10	4.50E-10	1.65E-10	6.14E-11	5.08E-11	-BDL-	-BDL-	2.37E-10	
X DREDGE MATERIAL						0.000	0.000	0.447	2.143	0.688	0.000	0.000	0.000	0.000	0.000	
SAMPLE D																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD						1.74E-10 1.82E-10										
X DREDGE MATERIAL						0.000 0.000										
SAMPLE E																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD						4.314 4.316										
X DREDGE MATERIAL						0.615 0.675										
						-BDL- 1.06E-10										
						0.000 0.000										
SAMPLE F																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
X DREDGE MATERIAL																
SAMPLE G																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
X DREDGE MATERIAL																
SAMPLE H																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
X DREDGE MATERIAL																

COORDINATES			HOLE NO.	LOCATION											
F	E	4 5	46	PINOLE SHOAL											
SAMPLING DATES			3APR74	13MAY74	3JUN74	24JUL74	1AUG74	5SEP74	9OCT74	15NOV74	30DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)			17.5	17.0	19.5	15.5	17.5	17.0	17.0	18.0	18.5				
THICKNESS OF LAYERS (IN)															
FLUFF			0.5	2.0	3.0	1.0	1.0	0.0	2.0	1.0	0.0				
ACTIVE			12.0	8.0	8.0	9.0	6.0	12.0	8.0	7.0	3.0				
INACTIVE			0.0	13.0	8.0	8.0	8.0	10.0	12.0	18.0	22.0				
SAMPLE A			3778	1495	1597	2053	2173	2533	2899	3280	3559				
G.DRY/CC.WET MUD			0.555	0.609	0.673	0.608	0.561	0.695	0.555	0.476	0.582				
G.IR/G.DRY MUD			2.86E-10	7.49E-10	4.52E-10	3.88E-10	3.48E-10	2.33E-10	3.31E-10	6.52E-10	1.26E-10				
Σ DREDGE MATERIAL			0.000	2.219	0.696	0.367	0.164	0.000	0.075	1.721	0.000				
SAMPLE B			3779	1496	1598	2054	2174	2534	2900	3281	3560				
G.DRY/CC.WET MUD			0.523	0.596	0.475	0.391	0.641	0.571	0.641	0.550	0.480				
G.IR/G.DRY MUD			-BDL -	4.57E-09	5.27E-10	2.90E-10	3.35E-10	6.01E-10	2.25E-09	2.37E-10	-BDL -				
Σ DREDGE MATERIAL			0.000	21.805	1.080	0.000	0.099	1.461	9.915	0.000	0.000				
SAMPLE C			3780	1497	1599	2055	2175	2535	2901	3282	3561				
G.DRY/CC.WET MUD			0.540	0.494	0.519	0.521	0.547	0.604	1.084	0.741	0.543				
G.IR/G.DRY MUD			5.19E-10	3.33E-09	6.86E-10	-BDL -	4.40E-10	3.29E-11	2.37E-09	3.21E-10	1.22E-10				
Σ DREDGE MATERIAL			1.042	15.451	1.899	0.000	0.635	0.000	10.554	0.027	0.000				
SAMPLE D			4317	4319	4319	4320	4320	4322	4322	4323					
G.DRY/CC.WET MUD			0.589	0.600	0.600	0.554	0.554	1.116	1.116	0.868					
G.IR/G.DRY MUD			5.91E-11	1.85E-10	3.33E-10	3.33E-10	3.33E-10	5.30E-10	5.30E-10	-BDL -					
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.085	0.085	1.099	1.099	0.000					
SAMPLE E															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE F			4318	4318	4318	4318	4318	4318	4318	4318	4323				
G.DRY/CC.WET MUD			0.524	0.524	0.524	0.524	0.524	0.524	0.524	0.524	0.868				
G.IR/G.DRY MUD			4.93E-11	4.93E-11	4.93E-11	4.93E-11	4.93E-11	4.93E-11	4.93E-11	4.93E-11	-BDL -				
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
SAMPLE G			4321	4321	4321	4321	4321	4321	4321	4321	4321				
G.DRY/CC.WET MUD			0.587	0.587	0.587	0.587	0.587	0.587	0.587	0.587	0.587				
G.IR/G.DRY MUD			3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10				
Σ DREDGE MATERIAL			0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359				
SAMPLE H			4321	4321	4321	4321	4321	4321	4321	4321	4321				
G.DRY/CC.WET MUD			0.587	0.587	0.587	0.587	0.587	0.587	0.587	0.587	0.587				
G.IR/G.DRY MUD			3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10	3.86E-10				
Σ DREDGE MATERIAL			0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359				

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COORDINATES	HOLE NO.	LOCATION	21MAR74	4APR74	8MAY74	13JUN74	26JUL74	8AUG74	9SEP74	20CT74	1NOV74	20DEC74
1 F 7 6	47	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES			21MAR74	4APR74	8MAY74	13JUN74	26JUL74	8AUG74	9SEP74	20CT74	1NOV74	20DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)			2.5	3.5	3.0	2.5	2.0	2.0	3.0	3.0	3.0	2.5
THICKNESS OF LAYERS (IN)												
FLUFF			0.5	1.0	4.0	2.0	1.0	1.0	1.0	1.0	0.0	0.0
ACTIVE			10.0	6.0	6.0	7.0	7.0	8.0	11.0	6.0	13.0	3.0
INACTIVE			13.0	12.0	8.0	5.0	5.0	2.0	6.0	9.0	14.0	20.0
SAMPLE A			3817	3691	1336	1726	2089	2365	2653	2773	3070	3562
G.DRY/CC.WET MUD			0.456	0.729	0.567	0.727	0.658	0.694	0.779	0.664	0.703	0.945
G.IR/G.DRY MUD			8.65E-10	6.51E-10	6.33E-10	3.47E-10	2.42E-10	2.62E-10	2.94E-10	2.90E-10	0.00E+00	2.97E-10
X DREDGE MATERIAL			2.817	1.717	1.624	0.160	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE B			3818	3692	1337	1727	2090	2366	2654	2774	3071	3563
G.DRY/CC.WET MUD			0.586	0.634	0.596	0.578	0.465	0.666	0.665	0.653	0.554	0.603
G.IR/G.DRY MUD			7.16E-10	7.89E-11	6.98E-10	2.40E-10	3.57E-10	3.54E-10	3.50E-10	-80L - 2.37E-10	0.000	3.63E-10
X DREDGE MATERIAL			2.053	0.000	1.957	0.000	0.209	0.196	0.176	0.000	0.000	0.241
SAMPLE C			3819	3693	1338	1728	2091	2367	2655	2775	3072	3564
G.DRY/CC.WET MUD			0.575	0.600	0.719	0.680	0.669	0.663	0.666	0.657	0.768	0.629
G.IR/G.DRY MUD			7.33E-10	1.87E-09	5.11E-10	1.88E-10	5.94E-10	3.37E-10	2.00E-10	2.39E-10	3.77E-10	5.69E-11
X DREDGE MATERIAL			2.138	7.988	1.000	0.000	1.424	0.110	0.000	0.000	0.310	0.000
SAMPLE D					4324	4326	4327				4827	
G.DRY/CC.WET MUD					0.566	0.581	0.633				0.623	
G.IR/G.DRY MUD					3.14E-10	3.85E-10	8.80E-11				2.37E-10	
X DREDGE MATERIAL					0.000	0.354	0.000				0.000	
SAMPLE E					4325						4828	
G.DRY/CC.WET MUD					0.667						0.669	
G.IR/G.DRY MUD					3.91E-10						4.30E-10	
X DREDGE MATERIAL					0.385						0.586	
SAMPLE F												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
X DREDGE MATERIAL												
SAMPLE G												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
X DREDGE MATERIAL												
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
X DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION								
1	E 6 5	48	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES		21MAR74	4APR74	8MAY74	5JUN74	19JUL74	7AUG74	9SEP74	11OCT74	22NOV74	17DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.5	4.0	5.0	4.5	5.0	5.0	5.0	5.0	5.0	4.5
THICKNESS OF LAYERS (IN)											
FLUFF		0.0	1.5	2.0	2.0	1.0	0.0	1.0	2.0	0.0	2.0
ACTIVE		9.0	14.0	7.0	8.0	6.0	7.0	9.0	10.0	2.0	5.0
INACTIVE		17.0	10.0	9.0	6.0	8.0	6.0	12.0	13.0	19.0	10.0
SAMPLE A		3820	3673	1348	1690	2017	2248	2611	2881	3346	3634
G.DRY/CC.WET MUD		0.669	0.679	0.574	0.545	0.633	0.494	0.565	0.525	0.616	0.668
G.IR/G.DRY MUD		4.54E-10	6.18E-10	1.09E-09	4.43E-10	1.30E-10	3.72E-10	2.75E-10	2.72E-10	-BDL	1.21E-10
Σ DREDGE MATERIAL		0.706	1.547	3.953	0.651	0.000	0.289	0.000	0.000	0.000	0.000
SAMPLE B		3821	3674	1349	1691	2018	2249	2612	2882	3347	3635
G.DRY/CC.WET MUD		0.496	0.648	0.504	0.582	0.609	0.622	0.633	0.560	0.615	0.584
G.IR/G.DRY MUD		2.18E-09	2.83E-11	7.15E-10	2.04E-10	1.42E-10	2.60E-10	2.47E-10	-BDL	4.43E-10	2.57E-10
Σ DREDGE MATERIAL		9.556	0.000	2.049	0.000	0.000	0.000	0.000	0.000	0.649	0.000
SAMPLE C		3822	3675	1350	1692	2019	2250	2613	2883	3348	3636
G.DRY/CC.WET MUD		0.579	0.612	0.575	0.589	0.625	0.604	0.620	0.653	0.629	0.609
G.IR/G.DRY MUD		9.73E-10	4.82E-10	1.88E-09	5.96E-11	4.35E-10	2.40E-10	5.31E-10	1.12E-10	-BDL	1.26E-10
Σ DREDGE MATERIAL		3.371	0.853	8.016	0.000	0.611	0.000	1.103	0.000	0.000	0.000
SAMPLE D				4360		4362		4364			
G.DRY/CC.WET MUD				0.606		0.577		0.740			
G.IR/G.DRY MUD				1.09E-10		4.48E-10		-BDL			
Σ DREDGE MATERIAL				0.000		0.678		0.000			
SAMPLE E				4361		4363		4365			
G.DRY/CC.WET MUD				0.622		0.709		0.633			
G.IR/G.DRY MUD				2.33E-10		2.75E-10		-BDL			
Σ DREDGE MATERIAL				0.000		0.000		0.000			
SAMPLE F											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE G											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE H											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											

COORDINATES		HOLE NO.		LOCATION											
H	E	6	5	49	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES		21MAR74	4APR74	8MAY74	5JUN74	19JUL74	7AUG74	4SEP74	11OCT74	22NOV74	17DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		6.0	6.0	5.0	6.0	6.5	5.5	7.0	7.0	6.0	6.0				
THICKNESS OF LAYERS (IN)															
FLUFF		0.5	2.0	3.0	2.0	0.0	1.0	1.0	2.0	0.0	1.0				
ACTIVE		9.0	18.0	6.0	8.0	5.0	9.0	9.0	7.0	2.0	6.0				
INACTIVE		12.0	5.0	12.0	4.0	10.0	10.0	8.0	12.0	21.0	18.0				
SAMPLE A		3823	3655	1414	1624	1975	2197	2521	2926	3244	3595				
G.DRY/CC.WET MUD		0.485	0.835	0.663	0.574	0.624	0.631	0.566	0.533	0.505	0.631				
G.IR/G.DRY MUD		2.92E-09	6.30E-10	3.53E-10	5.93E-10	1.04E-10	5.64E-10	1.93E-11	1.95E-09	3.68E-10	-BOL-				
Σ DREDGE MATERIAL		13.347	1.610	0.188	1.420	0.000	1.270	0.000	8.362	0.268	0.000				
SAMPLE B		3824	3656	1415	1625	1976	2198	2522	2927	3245	3596				
G.DRY/CC.WET MUD		0.576	0.595	0.597	0.538	0.629	0.823	0.575	0.561	0.607	0.544				
G.IR/G.DRY MUD		1.48E-09	4.82E-10	4.91E-10	3.61E-10	2.75E-10	1.77E-10	2.49E-10	1.05E-09	4.16E-10	6.08E-11				
Σ DREDGE MATERIAL		5.994	0.852	0.899	0.230	0.000	0.000	0.000	3.787	0.515	0.000				
SAMPLE C		3825	3657	1416	1626	1977	2199	2523	2928	3246	3597				
G.DRY/CC.WET MUD		0.477	0.617	0.550	0.532	0.580	0.790	0.571	0.584	0.420	0.554				
G.IR/G.DRY MUD		-BOL-	1.40E-09	6.78E-10	5.28E-10	-BOL-	2.81E-10	8.56E-11	7.20E-10	1.54E-10	3.00E-10				
Σ DREDGE MATERIAL		0.000	5.543	1.858	1.090	0.000	0.000	0.000	2.072	0.000	0.000				
SAMPLE D															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE E															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE F															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE G															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE H															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															

COORDINATES			HOLE NO.		LOCATION											
H E 5			50		SAN PABLO BAY FLATS (STAKED)											
SAMPLING DATES			21MAR74	12APR74	5MAY74	5JUN74	19JUL74	1AUG74	4SEP74	16OCT74	22NOV74	17DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)			7.5	7.0	8.0	7.5	7.5	8.0	7.0	7.5	7.5	8.0				
THICKNESS OF LAYERS (IN)																
FLUFF			0.4	1.5	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0				
ACTIVE			9.0	7.0	6.0	13.0	3.0	7.0	9.0	6.0	1.0	5.0				
INACTIVE			13.0	12.0	8.0	6.0	11.0	6.0	6.0	10.0	13.0	19.0				
SAMPLE A			3733	1144	1369	1645	1966	2281	2548	2980	3247	3580				
G.DRY/CC.WET MUD			0.786	0.356	0.644	0.469	0.601	0.616	0.799	0.563	0.638	0.524				
G.IR/G.DRY MUD			3.68E-10	4.87E-09	2.57E-10	9.53E-10	3.44E-10	2.66E-10	4.35E-09	1.67E-10	3.45E-11	1.85E-10				
* DREDGE MATERIAL			0.268	23.348	0.000	3.265	0.143	0.000	23.250	0.000	0.000	0.000				
SAMPLE B			3734	1145	1370	1646	1967	2282	2549	2981	3248	3581				
G.DRY/CC.WET MUD			0.614	0.538	0.543	0.500	0.599	0.545	0.568	0.686	0.544	0.459				
G.IR/G.DRY MUD			2.19E-10	9.03E-10	4.55E-10	1.10E-09	4.67E-10	-80L- 7.11E-10	1.13E-09	1.82E-10	-80L-	0.000				
* DREDGE MATERIAL			0.000	3.009	0.711	4.029	0.775	0.000	2.026	4.182	0.000	0.000				
SAMPLE C			3735	1146	1371	1647	1968	2283	2550	2982	3249	3582				
G.DRY/CC.WET MUD			0.555	0.563	0.611	0.582	0.591	0.575	0.670	0.838	0.607	0.425				
G.IR/G.DRY MUD			2.24E-10	4.56E-10	7.59E-10	9.44E-10	1.99E-10	7.04E-10	2.65E-10	8.44E-10	2.24E-10	-80L-				
* DREDGE MATERIAL			0.000	0.716	2.274	3.218	0.000	1.998	0.000	2.707	0.000	0.000				
SAMPLE D																
G.DRY/CC.WET MUD					4372	4374		4376		4377						
G.IR/G.DRY MUD					0.574	0.649		0.700		0.769						
* DREDGE MATERIAL					-80L-	1.95E-11		3.15E-10		9.25E-11						
					0.000	0.000		0.000		0.000						
SAMPLE E																
G.DRY/CC.WET MUD					4373	4375										
G.IR/G.DRY MUD					0.567	0.634										
* DREDGE MATERIAL					7.80E-11	1.26E-11										
					0.000	0.000										
SAMPLE F																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
* DREDGE MATERIAL																
SAMPLE G																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
* DREDGE MATERIAL																
SAMPLE H																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
* DREDGE MATERIAL																

4378  
0.829  
4.46E-10  
0.665

COORDINATES			HOLE NO.	LOCATION											
G	E	5	6	51	PINOLE SHOAL										
SAMPLING DATES		21MAR74	15APR74	5MAY74	6JUN74	10JUL74	5AUG74	4SEP74	7OCT74	4NOV74	30EC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		17.5	17.5	16.5	15.0	15.0	16.0	16.0	16.0	16.0	15.5				
THICKNESS OF LAYERS (IN)															
FLUFF		0.1	2.5	1.0	3.0	3.0	4.0	1.0	4.0	0.0	0.0				
ACTIVE		11.0	7.0	5.0	8.0	8.0	13.0	7.0	6.0	5.0	5.0				
INACTIVE		11.0	9.0	9.0	6.0	8.0	4.0	7.0	9.0	12.0	20.0				
SAMPLE A		3736	1126	1318	1696	1927	2250	2551	2860	3106	3532				
G.DRY/CC.WET MUD		0.507	0.342	0.518	0.546	0.482	0.596	0.592	0.890	0.478	0.548				
G.1R/G.DRY MUD		3.20E-10	1.13E-09	6.47E-10	6.60E-10	3.80E-10	4.08E-10	2.44E-10	-BDL-	2.13E-10	2.60E-10				
Σ DREDGE MATERIAL		0.021	4.198	1.696	1.764	0.330	0.474	0.000	0.000	0.000	0.000				
SAMPLE B		3737	1127	1319	1697	1928	2251	2552	2861	3107	3533				
G.DRY/CC.WET MUD		0.469	0.508	0.500	0.467	0.468	0.588	0.601	1.616	0.519	0.431				
G.1R/G.DRY MUD		5.37E-10	1.14E-09	6.21E-10	4.43E-10	4.02E-10	-BDL-	5.79E-10	2.47E-10	6.88E-10	2.09E-10				
Σ DREDGE MATERIAL		1.133	4.252	1.563	0.654	0.439	0.000	1.349	0.000	1.910	0.000				
SAMPLE C		3738	1128	1320	1698	1929	2262	2553	2862	3108	3534				
G.DRY/CC.WET MUD		0.566	0.563	0.447	0.467	0.534	0.531	0.584	1.340	0.582	0.561				
G.1R/G.DRY MUD		1.92E-10	1.30E-09	7.23E-10	5.73E-10	3.32E-10	2.14E-10	4.92E-09	2.67E-10	3.61E-10	-BDL-				
Σ DREDGE MATERIAL		0.000	5.063	2.086	1.316	0.081	0.000	23.622	0.000	0.229	0.000				
SAMPLE D		4531	4638	4379	4781	4381	4781	4381	4383	4829					
G.DRY/CC.WET MUD		0.538	0.552	0.563	0.563	0.598	0.598	0.564	1.469	0.672					
G.1R/G.DRY MUD		-BDL-	3.43E-10	2.01E-10	1.52E-10	3.56E-10	-BDL-	-BDL-	-BDL-	7.17E-11					
Σ DREDGE MATERIAL		0.000	0.141	0.000	0.000	0.000	0.000	0.207	0.000	0.000					
SAMPLE E		4639	4639	4639	4380	4380	4782	4382	4383	4829					
G.DRY/CC.WET MUD		0.595	0.595	0.595	0.549	0.549	0.544	0.594	1.469	0.672					
G.1R/G.DRY MUD		2.29E-10	2.29E-10	2.29E-10	8.68E-11	8.68E-11	1.13E-10	4.75E-10	-BDL-	7.17E-11					
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.816	0.000	0.000					
SAMPLE F		4532	4532	4532	4380	4380	4782	4382	4383	4829					
G.DRY/CC.WET MUD		0.523	0.523	0.523	0.549	0.549	0.544	0.594	1.469	0.672					
G.1R/G.DRY MUD		-BDL-	-BDL-	-BDL-	8.68E-11	8.68E-11	1.13E-10	4.75E-10	-BDL-	7.17E-11					
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.816	0.000	0.000					
SAMPLE G		4380	4380	4380	4380	4380	4380	4380	4380	4380					
G.DRY/CC.WET MUD		0.549	0.549	0.549	0.549	0.549	0.549	0.549	0.549	0.549					
G.1R/G.DRY MUD		8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11					
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000					
SAMPLE H		4380	4380	4380	4380	4380	4380	4380	4380	4380					
G.DRY/CC.WET MUD		0.549	0.549	0.549	0.549	0.549	0.549	0.549	0.549	0.549					
G.1R/G.DRY MUD		8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11	8.68E-11					
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000					



COORDINATES		HOLE NO.	LOCATION									
F	E	S	53	PINOLE SHOAL								
SAMPLING DATES		22MAR74	3APR74	13MAY74	3JUN74	31JUL74	23AUG74	4SEP74	9OCT74	6NOV74	4DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		18.5	19.0	18.5	21.5	21.0	21.5	21.5	21.0	21.5	22.0	
THICKNESS OF LAYERS (IN)												
FLUFF		0.2	0.5	1.5	2.0	0.0	0.0	1.0	1.5	0.0	0.0	
ACTIVE		11.0	10.0	9.0	7.0	14.0	3.0	6.0	5.0	6.0	2.0	
INACTIVE		8.0	12.0	15.0	8.0	0.0	18.0	13.0	8.0	23.0	20.0	
SAMPLE A		3853	3928	1441	1591	2149	2452	2524	2866	3193	3529	
G.DRY/CC.WET MUD		0.522	0.673	0.812	0.682	0.716	1.178	0.887	0.774	0.461	0.650	
G.IR/G.DRY MUD		4.25E-09	-BDL-	3.77E-10	2.91E-10	3.64E-10	-BDL-	4.55E-10	1.52E-11	5.02E-10	3.77E-10	
* DREDGE MATERIAL		20.177	0.000	0.313	0.000	0.247	0.000	0.711	0.000	0.954	0.311	
SAMPLE B		3854	3929	1442	1592	2150	2453	2525	2867	3194	3530	
G.DRY/CC.WET MUD		0.492	0.470	0.623	0.874	0.615	0.866	0.721	0.656	0.676	0.620	
G.IR/G.DRY MUD		6.76E-10	2.83E-10	3.51E-10	5.97E-10	4.54E-10	3.45E-10	9.84E-11	-BDL-	4.85E-11	-BDL-	
* DREDGE MATERIAL		1.845	0.000	0.178	1.441	0.708	0.151	0.000	0.000	0.000	0.000	
SAMPLE C		3855	3930	1443	1593	2151	2454	2526	2868	3195	3531	
G.DRY/CC.WET MUD		0.944	0.724	0.527	1.004	0.668	0.758	0.702	0.922	0.703	0.660	
G.IR/G.DRY MUD		1.13E-09	-BDL-	6.74E-10	2.06E-09	7.00E-10	1.45E-10	-BDL-	1.71E-10	4.85E-11	6.70E-11	
* DREDGE MATERIAL		4.191	0.000	1.838	8.949	1.970	0.000	0.000	0.000	0.000	0.000	
SAMPLE D				4386	0513	4388						
G.DRY/CC.WET MUD				0.689	0.823	0.671						
G.IR/G.DRY MUD				1.85E-10	5.75E-10	1.28E-10						
* DREDGE MATERIAL				0.000	1.330	0.000						
SAMPLE E												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												
SAMPLE F					0514	4389						
G.DRY/CC.WET MUD					0.724	0.727						
G.IR/G.DRY MUD					7.43E-10	3.54E-11						
* DREDGE MATERIAL					2.188	0.000						
SAMPLE G				4387								
G.DRY/CC.WET MUD				0.812								
G.IR/G.DRY MUD				-BDL-								
* DREDGE MATERIAL				0.000								
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
* DREDGE MATERIAL												

COORDINATES		HOLE LOCATION		SAN PABLO BAY FLATS (STAKED)													
G	C	B	3	NO.	54												
SAMPLING DATES				14MAR74	26MAR74	4APR74	3MAY74	10JUN74	26JUL74	8AUG74	16SEP74	20CT74	1NOV74	20DEC74			
DEPTH OF SEDIMENT BELOW MLLW (FT)				1.0	2.0	2.0	2.0	2.5	1.5	2.0	2.0	2.0	2.0	1.5			
THICKNESS OF LAYERS (IN)																	
FLUFF				1.2	1.0	-NA-	2.0	3.0	2.0	2.5	1.0	1.0	0.0	1.0			
ACTIVE				16.0	8.0	-NA-	4.0	10.0	6.0	10.0	14.0	8.0	8.0	3.0			
INACTIVE				4.0	11.0	-NA-	15.0	11.0	11.0	10.0	7.0	7.0	8.0	18.0			
SAMPLE A				1060	3889	3694	1402	1708	2092	2320	2683	2776	3073	3565			
G. DRY/CC. WET MUD				0.333	0.728	0.756	0.591	0.566	0.542	0.922	0.625	0.851	0.671	0.673			
G. IR/G. DRY MUD				3.36E-09	3.39E-10	1.00E-10	7.29E-10	3.74E-10	6.46E-10	2.12E-10	-BDL-	1.58E-10	1.02E-10	6.95E-10			
Σ DREDGE MATERIAL				15.624	0.117	0.000	2.116	0.296	1.691	0.000	0.000	0.000	0.000	1.944			
SAMPLE B				1062	3890	3695	1403	1709	2093	2321	2684	2777	3074	3566			
G. DRY/CC. WET MUD				0.591	0.535	0.549	0.598	0.527	0.558	0.591	0.541	0.651	0.577	0.610			
G. IR/G. DRY MUD				3.28E-09	0.00E+00	5.53E-10	5.75E-10	2.75E-10	5.10E-10	3.11E-10	5.73E-10	2.16E-10	3.99E-10	2.48E-10			
Σ DREDGE MATERIAL				15.187	0.000	1.217	1.328	0.000	0.995	0.000	1.320	0.000	0.424	0.000			
SAMPLE C				1061	3891	3696	1404	1710	2094	2322	2685	2778	3075	3567			
G. DRY/CC. WET MUD				0.586	0.647	0.567	0.569	0.618	0.715	0.623	0.680	0.624	0.643	0.690			
G. IR/G. DRY MUD				3.28E-09	7.13E-10	2.12E-09	4.99E-10	3.05E-10	3.98E-10	-BDL-	2.45E-10	2.44E-10	1.02E-10	1.24E-10			
Σ DREDGE MATERIAL				15.215	2.034	9.234	0.940	0.000	0.422	0.000	0.000	0.000	0.000	0.000			
SAMPLE D				4390			4392	4394									
G. DRY/CC. WET MUD				0.555			0.493	0.657									
G. IR/G. DRY MUD				8.46E-11			-BDL-	1.43E-10									
Σ DREDGE MATERIAL				0.000			0.000	0.000									
SAMPLE E				4391			4393	4395									
G. DRY/CC. WET MUD				0.568			0.446	0.435									
G. IR/G. DRY MUD				-BDL-			3.38E-11	5.87E-11									
Σ DREDGE MATERIAL				0.000			0.000	0.000									
SAMPLE F																	
G. DRY/CC. WET MUD																	
G. IR/G. DRY MUD																	
Σ DREDGE MATERIAL																	
SAMPLE G																	
G. DRY/CC. WET MUD																	
G. IR/G. DRY MUD																	
Σ DREDGE MATERIAL																	
SAMPLE H																	
G. DRY/CC. WET MUD																	
G. IR/G. DRY MUD																	
Σ DREDGE MATERIAL																	

COORDINATES			HOLE LOCATION										
H	C	B	NO. 55 SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES			14MAR74	26MAR74	4APR74	24MAY74	12JUN74	26JUL74	8AUG74	16SEP74	20C174	1NOV74	20DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)			1.0	2.0	2.0	2.0	1.5	1.5	2.0	2.0	2.0	2.0	1.5
THICKNESS OF FLUFF LAYERS (IN)			1.5	0.5	2.0	2.0	2.0	0.0	2.0	0.0	1.0	0.0	1.0
ACTIVE			18.0	8.0	10.0	7.0	10.0	13.0	10.0	14.0	9.0	8.0	3.0
INACTIVE			0.0	17.0	10.0	6.0	6.0	7.0	6.0	12.0	10.0	10.0	21.0
SAMPLE A			1036	3865	3748	1504	1729	2095	2323	2686	2824	3076	3556
G. DRY/CC. WET MUD			0.834	0.751	0.795	0.676	0.655	0.586	0.892	0.769	0.685	0.616	0.707
G. IR/G. DRY MUD			3.79E-09	8.61E-11	3.32E-11	1.73E-09	3.53E-10	2.86E-10	2.00E-10	1.60E-11	4.32E-10	3.17E-10	3.15E-10
Σ DREDGE MATERIAL			17.800	0.000	0.000	7.252	0.191	0.000	0.000	0.000	0.594	0.004	0.000
SAMPLE B			1037	3866	3749	1505	1730	2096	2324	2687	2825	3077	3557
G. DRY/CC. WET MUD			0.538	0.569	0.618	0.574	0.635	0.582	0.687	0.659	0.663	0.634	0.533
G. IR/G. DRY MUD			4.13E-09	8.32E-10	-BDL	1.88E-09	1.79E-10	-BDL	2.85E-10	-BDL	-BDL	4.24E-10	3.51E-10
Σ DREDGE MATERIAL			19.558	2.646	0.000	8.004	0.000	0.000	0.000	0.000	0.000	0.554	0.179
SAMPLE C			1038	3867	3750	1506	1731	2097	2325	2688	2826	3078	3558
G. DRY/CC. WET MUD			0.692	0.547	0.650	0.701	0.648	0.681	0.696	0.657	0.677	0.635	0.567
G. IR/G. DRY MUD			4.57E-09	4.70E-09	0.00E+00	1.42E-09	1.82E-10	3.36E-10	3.59E-10	1.06E-10	2.18E-10	6.52E-11	3.20E-10
Σ DREDGE MATERIAL			21.800	22.507	0.000	5.664	0.000	0.100	0.219	0.000	0.000	0.000	0.021
SAMPLE D			4396			4398			4640				
G. DRY/CC. WET MUD			0.538			0.592			0.610				
G. IR/G. DRY MUD			1.85E-10			1.61E-10			2.58E-10				
Σ DREDGE MATERIAL			0.000			0.000			0.000				
SAMPLE E			4397			4399			4641				
G. DRY/CC. WET MUD			0.503			0.625			0.617				
G. IR/G. DRY MUD			1.13E-10			4.51E-10			4.35E-10				
Σ DREDGE MATERIAL			0.000			0.692			0.610				
SAMPLE F													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE G													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE H													
G. DRY/CC. WET MUD													
G. IR/G. DRY MUD													
Σ DREDGE MATERIAL													

COORDINATES	HOLE NO.	LOCATION
D C 11 3	56	CARQUINEZ STRAIT
SAMPLING DATES	29MAR74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	99.0	
THICKNESS OF LAYERS (IN)	-NA-	
FLUFF	-NA-	
ACTIVE	-NA-	
INACTIVE		
SAMPLE A	NO SAMPLE	
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE B	NO SAMPLE	
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE C	NO SAMPLE	
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE D		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE E		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE F		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE G		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		
SAMPLE H		
G. DRY/CC. WET MUD		
G. IR/G. DRY MUD		
* DREDGE MATERIAL		

COORDINATES	HOLE NO.	LOCATION
D H 10 8	57	CARQUINEZ STRAIT
SAMPLING DATES	29MAR74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	57.0	
THICKNESS OF FLUFF LAYERS (IN)		-NA-
ACTIVE		-NA-
INACTIVE		-NA-
SAMPLE A		NO SAMPLE
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE B		NO SAMPLE
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE C		NO SAMPLE
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE D	3	
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE E		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE F		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE G		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		
SAMPLE H		
G.DRY/CC.WET MUD		
G.1R/G.DRY MUD		
* DREDGE MATERIAL		

COORDINATES			HOLE NO.	LOCATION						
E H 7 8	58	SAN PABLO BAY FLATS								
SAMPLING DATES		2APR74	2MAY74	3JUN74	9JUL74	1AUG74	3SEP74	1OCT74	5NOV74	6DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)		11.0	11.0	12.0	11.0	12.0	13.5	11.0	11.0	11.5
THICKNESS OF LAYERS (IN)										
FLUFF	0.2	1.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0
ACTIVE	11.0	9.0	9.0	5.0	6.0	6.0	8.0	6.0	8.0	3.0
INACTIVE	13.0	10.0	11.0	11.0	10.0	10.0	12.0	6.0	13.0	16.0
SAMPLE A		3919	1306	1609	1897	2170	2509	2767	3100	3577
G.DRY/CC.WET MUD	0.921	0.882	1.044	0.975	0.970	1.272	1.140	0.684	1.135	0.0
G.IR/G.DRY MUD	5.48E-10	5.68E-10	1.77E-10	1.21E-10	-BDL-	1.49E-10	3.45E-10	-BDL-	8.50E-11	3.0
Σ DREDGE MATERIAL	1.192	1.292	0.000	0.000	0.000	0.000	0.000	0.147	0.000	0.000
SAMPLE B		3920	1307	1610	1898	2171	2510	2768	3101	3578
G.DRY/CC.WET MUD	0.615	0.904	0.709	1.219	1.117	1.049	0.757	0.790	0.769	0.0
G.IR/G.DRY MUD	1.56E-10	4.35E-10	9.28E-10	1.02E-10	4.50E-10	7.14E-10	3.64E-10	3.42E-10	1.52E-10	0.000
Σ DREDGE MATERIAL	0.000	0.610	3.137	0.000	0.685	2.040	0.245	0.135	0.000	
SAMPLE C		3921	1308	1611	1899	2172	2511	2769	3102	3579
G.DRY/CC.WET MUD	1.664	0.958	0.763	0.679	0.880	0.837	0.752	1.001	0.773	0.0
G.IR/G.DRY MUD	-BDL-	4.85E-10	3.90E-10	3.17E-10	1.10E-10	-BDL-	-BDL-	1.27E-10	8.50E-11	0.000
Σ DREDGE MATERIAL	0.000	0.865	0.381	0.003	0.000	0.000	0.000	0.000	0.000	
SAMPLE D		4400	4402							
G.DRY/CC.WET MUD	0.835	0.616								
G.IR/G.DRY MUD	8.46E-11	1.30E-10								
Σ DREDGE MATERIAL	0.000	0.000								
SAMPLE E		4401	4403							
G.DRY/CC.WET MUD	0.917	0.531								
G.IR/G.DRY MUD	1.97E-10	2.43E-10								
Σ DREDGE MATERIAL	0.000	0.000								
SAMPLE F										
G.DRY/CC.WET MUD										
G.IR/G.DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE G										
G.DRY/CC.WET MUD										
G.IR/G.DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G.DRY/CC.WET MUD										
G.IR/G.DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES		HOLE NO.	LOCATION								
E	H	59	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES		2APR74	2MAY74	4JUN74	9JUL74	2AUG74	3SEP74	17OCT74	5NOV74	13DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		10.0	8.5	8.5	8.0	9.0	7.5	8.5	9.0	8.5	
THICKNESS OF LAYERS (IN)											
FLOUFF		0.4	1.5	1.5	2.0	3.0	0.0	2.0	0.0	2.0	
ACTIVE		20.0	8.0	6.0	5.0	6.0	5.0	7.0	5.0	6.0	
INACTIVE		0.0	6.0	12.0	11.0	15.0	9.0	14.0	12.0	17.0	
SAMPLE A		3922	1297	1603	1894	2203	2476	3022	3103	3364	
G.DRY/CC.WET MUD		0.674	0.697	0.746	0.687	0.696	0.836	0.659	0.549	0.494	
G.IR/G.DRY MUD		5.31E-11	1.61E-10	2.39E-10	3.96E-10	1.53E-10	2.68E-10	5.49E-10	2.00E-10	2.80E-10	
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.412	0.000	0.000	1.193	0.000	0.000	
SAMPLE B		3923	1298	1604	1895	2204	2477	3023	3104	3365	
G.DRY/CC.WET MUD		0.382	0.666	0.500	0.524	0.630	0.692	0.564	0.790	0.493	
G.IR/G.DRY MUD		-80L -	2.95E-10	2.67E-10	4.95E-10	2.92E-11	1.09E-10	1.08E-08	2.71E-10	3.03E-10	
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.919	0.000	0.000	53.623	0.000	0.000	
SAMPLE C		3924	1299	1605	1896	2205	2478	3024	3105	3366	
G.DRY/CC.WET MUD		0.474	0.529	0.516	0.628	0.513	0.670	0.553	0.784	0.590	
G.IR/G.DRY MUD		4.83E-10	4.48E-10	9.21E-10	4.72E-10	3.74E-10	1.59E-10	8.50E-10	1.87E-10	1.92E-09	
Σ DREDGE MATERIAL		0.854	0.677	3.103	0.803	0.298	0.000	2.739	0.000	8.224	
SAMPLE D			4404	4642	4406						4783
G.DRY/CC.WET MUD			0.584	0.711	0.569						0.647
G.IR/G.DRY MUD			-80L -	2.54E-10	1.24E-10						1.32E-10
Σ DREDGE MATERIAL			0.000	0.000	0.000						0.000
SAMPLE E			4405	4643	4407						4784
G.DRY/CC.WET MUD			0.495	0.617	0.706						0.634
G.IR/G.DRY MUD			2.28E-10	4.99E-10	4.28E-10						4.40E-10
Σ DREDGE MATERIAL			0.000	0.941	0.576						0.638
SAMPLE F											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE G											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE H											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											

COORDINATES			HOLE NO.	LOCATION											
E	H	6	3	SAN PABLO BAY FLATS (STAKED)											
SAMPLING DATES			2APR74	3MAY74	4JUN74	9JUL74	2AUG74	3SEP74	17OCT74	23NOV74	13DEC74				
DEPTH OF SEDIMENT BELOW MLW (FT)			9.0	7.0	7.5	6.0	8.0	7.5	7.5	8.0	8.0				
THICKNESS OF FLUFF LAYERS (IN)			0.1	2.0	1.0	2.0	4.0	1.0	1.0	0.0	1.0				
ACTIVE			14.0	6.0	8.5	8.0	8.0	6.0	6.0	3.0	5.0				
INACTIVE			10.0	6.0	8.0	9.0	8.0	8.0	9.0	23.0	14.0				
SAMPLE A			3766	1384	1618	1876	2188	2479	3049	3259	3640				
G. DRY/CC. WET MUD			0.631	0.539	0.573	0.608	0.688	0.656	0.574	0.517	0.564				
G. IR/G. DRY MUD			3.22E-10	5.60E-10	2.32E-11	5.08E-10	4.33E-10	5.54E-10	2.17E-09	1.54E-10	-BOL-				
Σ DREDGE MATERIAL			0.032	1.252	0.000	0.984	0.600	1.220	9.491	0.000	0.000				
SAMPLE B			3767	1385	1619	1877	2189	2480	3050	3260	3641				
G. DRY/CC. WET MUD			0.458	0.742	0.540	0.576	0.538	0.583	0.459	0.554	0.529				
G. IR/G. DRY MUD			-BOL-	8.85E-10	5.85E-10	2.20E-10	3.18E-10	3.86E-10	2.55E-10	9.99E-11	1.53E-10				
Σ DREDGE MATERIAL			0.000	2.918	1.380	0.000	0.013	0.358	0.000	0.000	0.000				
SAMPLE C			3768	1386	1620	1878	2190	2481	3051	3261	3642				
G. DRY/CC. WET MUD			0.701	0.653	0.545	0.668	0.592	0.618	0.636	0.561	0.523				
G. IR/G. DRY MUD			-BOL-	7.01E-10	1.44E-09	1.65E-10	1.73E-10	1.77E-10	4.43E-10	9.81E-11	4.98E-10				
Σ DREDGE MATERIAL			0.000	1.972	5.781	0.000	0.000	0.000	0.651	0.000	0.933				
SAMPLE D			4408	4409	4411	4410	4412	4412	4412	4830	4830				
G. DRY/CC. WET MUD			0.700	0.552	0.552	5.10E-10	0.617	0.617	0.636	0.561	0.523				
G. IR/G. DRY MUD			2.52E-10	3.08E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10				
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.996	0.996	0.651	0.000	0.933				
SAMPLE E			4408	4409	4411	4410	4412	4412	4412	4830	4830				
G. DRY/CC. WET MUD			0.700	0.552	0.552	5.10E-10	0.617	0.617	0.636	0.561	0.523				
G. IR/G. DRY MUD			2.52E-10	3.08E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10				
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.996	0.996	0.651	0.000	0.933				
SAMPLE F			4408	4409	4411	4410	4412	4412	4412	4830	4830				
G. DRY/CC. WET MUD			0.700	0.552	0.552	5.10E-10	0.617	0.617	0.636	0.561	0.523				
G. IR/G. DRY MUD			2.52E-10	3.08E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10				
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.996	0.996	0.651	0.000	0.933				
SAMPLE G			4408	4409	4411	4410	4412	4412	4412	4830	4830				
G. DRY/CC. WET MUD			0.700	0.552	0.552	5.10E-10	0.617	0.617	0.636	0.561	0.523				
G. IR/G. DRY MUD			2.52E-10	3.08E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10				
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.996	0.996	0.651	0.000	0.933				
SAMPLE H			4408	4409	4411	4410	4412	4412	4412	4830	4830				
G. DRY/CC. WET MUD			0.700	0.552	0.552	5.10E-10	0.617	0.617	0.636	0.561	0.523				
G. IR/G. DRY MUD			2.52E-10	3.08E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10	5.10E-10				
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.996	0.996	0.651	0.000	0.933				

COORDINATES			HOLE NO.	LOCATION							
E	C	3	61	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES			3APR74	2MAY74	3JUN74	9JUL74	2AUG74	3SEP74	17OCT74	5NOV74	13DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)			5.5	5.5	6.5	5.0	5.5	5.5	5.5	6.0	6.0
THICKNESS OF LAYERS (IN)											
FLUFF			1.5	1.5	1.5	2.0	3.0	0.0	1.0	0.0	1.0
ACTIVE			18.0	10.0	8.5	4.0	6.0	13.0	6.0	18.0	18.0
INACTIVE			0.0	6.0	9.0	9.0	11.0	5.0	13.0	8.0	8.0
SAMPLE A			3670	1309	1639	1870	2239	2482	3025	3139	3382
G. DRY/CC. WET MUD			0.578	0.728	0.649	0.611	0.671	0.684	0.427	0.468	0.656
G. IR/G. DRY MUD			3.35E-10	3.87E-10	4.80E-10	2.96E-10	2.63E-10	1.67E-10	9.05E-10	1.76E-10	4.39E-10
Σ DREDGE MATERIAL			0.097	0.365	0.842	0.000	0.000	0.000	3.020	0.000	0.630
SAMPLE B			3671	1310	1640	1871	2240	2483	3026	3140	3383
G. DRY/CC. WET MUD			0.593	0.752	0.737	0.596	0.718	0.669	0.573	0.695	0.614
G. IR/G. DRY MUD			5.95E-09	2.64E-09	8.23E-10	2.55E-10	3.23E-10	4.65E-11	4.13E-10	3.72E-10	1.98E-11
Σ DREDGE MATERIAL			28.890	11.920	2.603	0.000	0.036	0.000	0.497	0.287	0.000
SAMPLE C			3672	1311	1641	1872	2241	2484	3027	3141	3384
G. DRY/CC. WET MUD			0.712	0.710	0.664	0.845	0.681	0.749	0.789	0.650	0.749
G. IR/G. DRY MUD			2.67E-10	3.64E-10	1.16E-09	1.98E-10	4.17E-10	-BDL-	1.59E-09	3.25E-11	2.93E-10
Σ DREDGE MATERIAL			0.000	0.244	4.318	0.000	0.516	0.000	6.557	0.000	0.000
SAMPLE D					4413		4415				
G. DRY/CC. WET MUD					0.667		0.797				
G. IR/G. DRY MUD					1.38E-10		-BDL-				
Σ DREDGE MATERIAL					0.000		0.000				
SAMPLE E					4414						
G. DRY/CC. WET MUD					0.695						
G. IR/G. DRY MUD					5.62E-11						
Σ DREDGE MATERIAL					0.000						
SAMPLE F							4416				
G. DRY/CC. WET MUD							0.756				
G. IR/G. DRY MUD							1.73E-10				
Σ DREDGE MATERIAL							0.000				
SAMPLE G											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE H											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											

COORDINATES			HOLE NO.	LOCATION								
E	C	8	62	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES			3APR74	2MAY74	3JUN74	9JUL74	2AUG74	3SEP74	17OCT74	5NOV74	13DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)			5.0	5.0	6.5	5.5	5.5	5.0	5.5	5.0	5.0	
THICKNESS OF FLUFF LAYERS (IN)			2.0	1.5	1.0	2.0	2.0	0.0	1.0	0.0	0.0	
ACTIVE			15.0	6.0	7.0	6.0	5.0	6.0	6.0	13.0	6.0	
INACTIVE			5.0	10.0	4.0	10.0	7.0	12.0	13.0	6.0	17.0	
SAMPLE A			3739	1303	1600	1888	2215	2485	3052	3142	3297	
G.DRY/CC.WET MUD			0.822	0.812	0.861	0.753	0.826	0.959	0.658	0.610	0.751	
G.IR/G.DRY MUD			2.47E-09	4.57E-10	3.17E-10	1.28E-10	7.24E-10	-BOL-	5.67E-10	1.37E-10	3.06E-10	
Σ DREDGE MATERIAL			11.039	0.725	0.003	0.000	2.094	0.000	1.285	0.000	0.000	
SAMPLE B			3740	1304	1601	1889	2216	2486	3053	3143	3398	
G.DRY/CC.WET MUD			0.600	0.787	0.891	0.727	0.721	0.878	0.833	0.720	0.801	
G.IR/G.DRY MUD			2.40E-10	3.10E-10	3.91E-10	8.49E-11	4.06E-10	-BOL-	1.86E-10	3.16E-10	-BOL-	
Σ DREDGE MATERIAL			0.000	0.000	0.385	0.000	0.461	0.000	0.000	0.000	0.000	
SAMPLE C			3741	1305	1602	1890	2217	2487	3054	3144	3399	
G.DRY/CC.WET MUD			0.832	0.783	0.820	0.854	0.836	0.854	0.726	0.713	0.763	
G.IR/G.DRY MUD			1.86E-10	3.45E-10	1.23E-09	1.73E-10	3.93E-10	1.55E-10	8.26E-09	1.17E-10	2.47E-10	
Σ DREDGE MATERIAL			0.000	0.146	4.683	0.000	0.393	0.000	40.726	0.000	0.000	
SAMPLE D					4417		4419					
G.DRY/CC.WET MUD					0.764		0.876					
G.IR/G.DRY MUD					7.28E-11		0.00E+00					
Σ DREDGE MATERIAL					0.000		0.000					
SAMPLE E					4418		4420					
G.DRY/CC.WET MUD					0.818		0.812					
G.IR/G.DRY MUD					5.34E-11		1.84E-10					
Σ DREDGE MATERIAL					0.000		0.000					
SAMPLE F												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE LOCATION									
H	C	9	9	NO.	63	MARE ISLAND STRAIT					
SAMPLING DATES		22APR74	7MAY74	14JUN74	25JUL74	21AUG74	16SEP74	18OCT74	21NOV74	5DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		22.0	21.0	20.0	18.5	20.5	21.0	23.0	22.5	20.5	
THICKNESS OF LAYERS (IN)											
FLUFF		2.0	1.5	2.5	1.0	1.0	1.0	1.0	0.0	0.0	
ACTIVE		6.0	8.0	7.0	8.0	11.0	10.0	11.0	6.0	4.0	
INACTIVE		6.0	8.0	6.0	8.0	8.0	4.0	7.0	14.0	14.0	
SAMPLE A		1267	1345	1759	2077	2443	2689	3058	3298	3502	
G. DRY/CC. WET MUD		0.611	0.711	0.606	0.674	0.599	0.529	0.486	0.592	0.678	
G. IR/G. DRY MUD		5.82E-10	7.54E-10	5.27E-10	5.56E-09	2.13E-10	-80L	1.71E-10	2.46E-10	1.52E-10	
Σ DREDGE MATERIAL		1.364	2.249	1.081	26.914	0.000	0.000	0.000	0.000	0.000	
SAMPLE B		1268	1346	1760	2078	2444	2690	3059	3299	3503	
G. DRY/CC. WET MUD		0.528	0.588	0.593	0.492	0.575	0.574	0.567	0.574	0.563	
G. IR/G. DRY MUD		4.78E-10	4.83E-10	6.61E-10	2.23E-09	1.07E-09	3.21E-10	3.16E-10	8.52E-11	1.01E-09	
Σ DREDGE MATERIAL		0.833	0.856	1.768	9.829	3.670	0.026	0.002	0.000	3.571	
SAMPLE C		1269	1347	1761	2079	2445	2691	3060	3300	3504	
G. DRY/CC. WET MUD		0.554	0.579	0.592	0.598	0.563	0.563	0.607	0.668	0.426	
G. IR/G. DRY MUD		1.99E-10	4.79E-10	1.52E-10	3.04E-09	7.74E-11	1.54E-10	1.13E-09	2.61E-10	5.31E-10	
Σ DREDGE MATERIAL		0.000	0.834	0.000	13.968	0.000	0.000	4.167	0.000	1.105	
SAMPLE D											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE E											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE F											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE G											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE H											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											

COORDINATES		HOLE NO.		LOCATION																																															
H	H 9 10	64	MARE ISLAND STRAIT	22APR74	7MAY74	14JUN74	23JUL74	21AUG74	18SEP74	18OCT74	21NOV74	50EC74																																							
SAMPLING DATES				25.5	25.5	26.5	23.0	22.5	23.0	28.0	25.5	26.5																																							
DEPTH OF SEDIMENT BELOW MLLW (FT)				25.5	25.5	26.5	23.0	22.5	23.0	28.0	25.5	26.5																																							
THICKNESS OF LAYERS (IN)				1.0	1.5	2.0	0.0	0.0	0.0	1.0	0.0	0.0																																							
FLUFF				10.0	4.0	7.0	5.0	6.0	6.0	5.0	4.0	2.0																																							
ACTIVE				14.0	11.0	8.0	12.0	10.0	14.0	10.0	21.0	21.0																																							
INACTIVE																																																			
SAMPLE A				1228	1357	1771	1999	2434	2713	3040	3304	3505																																							
G. DRY/CC. WET MUD				0.348	0.580	0.630	0.690	0.763	0.465	0.594	0.515	0.694																																							
G. IR/G. DRY MUD				5.17E-09	6.77E-10	4.00E-10	3.60E-10	3.06E-10	-BOL-	-BOL-	4.91E-10	8.12E-11																																							
Σ DREDGE MATERIAL				24.872	1.854	0.429	0.224	0.000	0.000	0.000	0.900	0.000																																							
SAMPLE B				1229	1358	1772	2000	2435	2714	3041	3305	3506																																							
G. DRY/CC. WET MUD				0.566	0.543	0.586	0.524	0.510	0.567	0.585	0.599	0.660																																							
G. IR/G. DRY MUD				5.38E-09	7.74E-10	5.30E-10	1.84E-10	4.32E-10	4.23E-10	8.45E-11	2.91E-10	1.58E-10																																							
Σ DREDGE MATERIAL				25.954	2.350	1.098	0.000	0.593	0.548	0.000	0.000	0.000																																							
SAMPLE C				1230	1359	1773	2001	2436	2715	3042	3306	3507																																							
G. DRY/CC. WET MUD				0.604	0.580	0.567	0.535	0.626	0.604	0.671	0.594	0.520																																							
G. IR/G. DRY MUD				1.52E-09	7.73E-10	5.44E-10	2.21E-10	3.18E-11	3.93E-10	4.19E-10	2.57E-10	2.48E-10																																							
Σ DREDGE MATERIAL				6.182	2.343	1.170	0.000	0.000	0.395	0.528	0.000	0.000																																							
SAMPLE D											4787																																								
G. DRY/CC. WET MUD											0.595																																								
G. IR/G. DRY MUD											-BOL-																																								
Σ DREDGE MATERIAL											0.000																																								
SAMPLE E																																																			
G. DRY/CC. WET MUD																																																			
G. IR/G. DRY MUD																																																			
Σ DREDGE MATERIAL																																																			
SAMPLE F											4788																																								
G. DRY/CC. WET MUD											0.585																																								
G. IR/G. DRY MUD											1.60E-09																																								
Σ DREDGE MATERIAL											6.563																																								
SAMPLE G																																																			
G. DRY/CC. WET MUD																																																			
G. IR/G. DRY MUD																																																			
Σ DREDGE MATERIAL																																																			
SAMPLE H																																																			
G. DRY/CC. WET MUD																																																			
G. IR/G. DRY MUD																																																			
Σ DREDGE MATERIAL																																																			

4788  
0.585  
1.60E-09  
6.563

COORDINATES		HOLE NO.		LOCATION											
G 1	7 4	65	74	SAN PABLO BAY FLATS (STAKED)											
SAMPLING DATES		11APR74	3MAY74	10JUN74	23JUL74	15AUG74	16SEP74	20CT74	22NOV74	12DEC74					
DEPTH OF SEDIMENT BELOW MLLW (FT):		5.0	5.0	5.5	5.0	6.0	5.0	5.5	5.0	5.5	5.0	5.5			
THICKNESS OF LAYERS (IN)															
FLUFF		1.5	2.0	2.5	1.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0			
ACTIVE		7.0	6.0	8.0	7.0	10.0	9.0	9.0	6.0	4.0	4.0	4.0			
INACTIVE		13.0	15.0	9.0	13.0	9.0	8.0	8.0	12.0	19.0	15.0	15.0			
SAMPLE A		3709	1393	1711	2002	2356	2692	2827	3250	3406					
G.DRY/CC.WET MUD		0.541	0.480	0.632	0.635	1.030	0.721	0.561	0.464	0.451					
G.IR/G.DRY MUD		7.58E-10	4.36E-10	2.98E-10	2.15E-10	1.84E-10	2.92E-10	1.58E-10	3.79E-10	2.17E-10					
Σ DREDGE MATERIAL		2.266	0.616	0.000	0.000	0.000	0.000	0.000	0.322	0.000					
SAMPLE B		3710	1394	1712	2003	2357	2693	2828	3251	3407					
G.DRY/CC.WET MUD		0.614	0.580	0.603	0.700	0.659	0.587	0.556	0.608	0.640					
G.IR/G.DRY MUD		7.67E-10	3.96E-10	6.26E-10	7.46E-10	1.33E-10	6.67E-11	2.51E-10	2.38E-10	2.07E-09					
Σ DREDGE MATERIAL		2.315	0.410	1.589	2.203	0.000	0.000	0.000	0.000	8.978					
SAMPLE C		3711	1395	1713	2004	2358	2694	2829	3252	3408					
G.DRY/CC.WET MUD		0.606	0.651	0.532	0.553	0.564	0.603	0.610	0.654	0.577					
G.IR/G.DRY MUD		2.53E-09	5.65E-10	6.03E-10	4.52E-10	2.96E-10	2.29E-10	2.13E-10	0.00E+00	1.64E-10					
Σ DREDGE MATERIAL		11.337	1.277	1.472	0.696	0.000	0.000	0.000	0.000	0.000					
SAMPLE D		4866	4425	4421	4423								4832		
G.DRY/CC.WET MUD		0.494	0.611	0.541	0.604								0.510		
G.IR/G.DRY MUD		2.72E-09	1.90E-10	3.13E-10	2.73E-10								8.89E-11		
Σ DREDGE MATERIAL		12.345	0.000	0.000	0.000								0.000		
SAMPLE E		4426	4426	4424	4424								4833		
G.DRY/CC.WET MUD		0.620	0.620	0.598	0.598								0.532		
G.IR/G.DRY MUD		2.47E-10	2.47E-10	6.81E-11	6.81E-11								2.07E-10		
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000								0.000		
SAMPLE F		4422	4422	4422	4422								4832		
G.DRY/CC.WET MUD		0.592	0.592	0.592	0.592								0.510		
G.IR/G.DRY MUD		-BDL -	-BDL -	-BDL -	-BDL -								8.89E-11		
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000								0.000		
SAMPLE G		4832	4832	4832	4832								4833		
G.DRY/CC.WET MUD		0.510	0.510	0.510	0.510								0.532		
G.IR/G.DRY MUD		8.89E-11	8.89E-11	8.89E-11	8.89E-11								2.07E-10		
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000								0.000		
SAMPLE H		4833	4833	4833	4833								4832		
G.DRY/CC.WET MUD		0.532	0.532	0.532	0.532								0.510		
G.IR/G.DRY MUD		2.07E-10	2.07E-10	2.07E-10	2.07E-10								8.89E-11		
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000								0.000		



COORDINATES		HOLE NO.	LOCATION		SAN PABLO BAY FLATS (STAKED)									
H	S	8	67											
SAMPLING DATES		11APR74	8MAY74	5JUN74	19JUL74	7AUG74	4SEP74	11OCT74	22NOV74	17DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		5.0	5.0	5.5	5.0	5.0	5.0	5.0	5.0	5.0				
THICKNESS OF LAYERS (IN)														
FLUFF		2.0	2.0	2.0	0.0	0.0	1.0	1.0	0.0	1.0				
ACTIVE		6.0	6.0	9.0	3.0	5.0	8.0	8.0	2.0	8.0				
INACTIVE		12.0	12.0	9.0	10.0	11.0	6.0	12.0	19.0	16.0				
SAMPLE A		3706	1405	1588	2014	2185	2527	2884	3310	3625				
G. DRY/CC. WET MUD		0.717	0.665	0.601	0.518	0.699	0.667	0.551	0.434	0.545				
G. IR/G. DRY MUD		1.01E-09	5.54E-10	3.43E-10	5.61E-10	5.04E-10	2.91E-10	2.30E-10	6.59E-10	-BOL-				
* DREDGE MATERIAL		3.560	1.223	0.141	1.255	0.967	0.000	0.000	1.762	0.000				
SAMPLE B		3707	1406	1589	2015	2186	2528	2885	3311	3626				
G. DRY/CC. WET MUD		0.739	0.704	0.649	0.698	0.639	0.604	0.641	0.717	0.533				
G. IR/G. DRY MUD		3.87E-10	5.12E-10	5.34E-10	4.22E-10	4.68E-10	1.22E-09	1.77E-10	6.60E-10	5.87E-10				
* DREDGE MATERIAL		0.367	1.006	1.117	0.542	0.780	4.639	0.000	1.767	1.391				
SAMPLE C		3708	1407	1590	2016	2187	2529	2886	3312	3627				
G. DRY/CC. WET MUD		0.636	0.619	0.570	0.620	0.586	0.586	0.594	0.689	0.598				
G. IR/G. DRY MUD		4.26E-10	1.25E-09	2.17E-10	4.50E-11	2.99E-10	5.12E-10	2.56E-10	1.32E-10	0.000				
* DREDGE MATERIAL		0.565	4.804	0.000	0.000	0.000	LOST	1.007	0.000	0.000				
SAMPLE D		4433	4433	4433	4433	4433	4433	4433	4433	4433				
G. DRY/CC. WET MUD		0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635				
G. IR/G. DRY MUD		3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10				
* DREDGE MATERIAL		0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321				
SAMPLE E		4433	4433	4433	4433	4433	4433	4433	4433	4433				
G. DRY/CC. WET MUD		0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635				
G. IR/G. DRY MUD		3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10				
* DREDGE MATERIAL		0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321				
SAMPLE F		4433	4433	4433	4433	4433	4433	4433	4433	4433				
G. DRY/CC. WET MUD		0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635				
G. IR/G. DRY MUD		3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10				
* DREDGE MATERIAL		0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321				
SAMPLE G		4433	4433	4433	4433	4433	4433	4433	4433	4433				
G. DRY/CC. WET MUD		0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635				
G. IR/G. DRY MUD		3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10				
* DREDGE MATERIAL		0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321				
SAMPLE H		4433	4433	4433	4433	4433	4433	4433	4433	4433				
G. DRY/CC. WET MUD		0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635				
G. IR/G. DRY MUD		3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10	3.79E-10				
* DREDGE MATERIAL		0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321				

COORDINATES			HOLE NO.	LOCATION								
H	H	6	3	58	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		11APR74	8MAY74	5JUN74	19JUL74	7AUG74	4SEP74	11OCT74	22NOV74	17DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		5.0	5.5	6.0	6.5	6.0	6.5	6.0	6.0	6.5		
THICKNESS OF LAYERS (IN)												
FLUFF		2.0	2.0	2.0	1.0	0.0	1.0	2.0	1.0	1.0		
ACTIVE		5.0	9.0	9.0	6.0	7.0	11.0	9.0	1.0	6.0		
INACTIVE		10.0	8.0	7.0	8.0	10.0	4.0	9.0	20.0	17.0		
SAMPLE A		3712	1390	1630	1984	2209	2530	2887	3253	3583		
G. DRY/CC. WET MUD		0.623	0.522	0.651	0.569	0.505	0.623	0.591	0.544	0.550		
G. IR/G. DRY MUD		4.92E-10	5.68E-10	6.69E-10	7.71E-10	2.45E-10	3.75E-10	4.62E-10	4.62E-10	1.63E-10		
X DREDGE MATERIAL		0.905	1.294	1.809	2.336	0.000	1.272	0.322	0.750	0.000		
SAMPLE B		3713	1391	1631	1985	2210	2531	2888	3254	3584		
G. DRY/CC. WET MUD		0.580	0.543	0.523	0.632	0.583	0.622	0.487	0.596	0.535		
G. IR/G. DRY MUD		9.63E-10	5.51E-10	1.13E-09	2.23E-10	4.76E-10	4.00E-12	1.84E-10	1.30E-10	8.37E-11		
X DREDGE MATERIAL		3.319	1.204	4.158	0.000	0.820	0.000	0.000	0.000	0.000		
SAMPLE C		1392	1632	1986	2211	2532	2889	3255	3585			
G. DRY/CC. WET MUD		LOST	0.572	0.597	0.620	0.669	0.606	0.714	0.629	0.533		
G. IR/G. DRY MUD		SAMPLE	5.46E-10	4.25E-10	7.58E-10	4.63E-10	4.00E-12	2.01E-10	9.61E-11	2.60E-10		
X DREDGE MATERIAL			1.181	0.560	2.268	0.752	0.000	0.000	0.000	0.000		
SAMPLE D		4436	4438	4439	4440							
G. DRY/CC. WET MUD		0.516	0.577	0.616	0.577							
G. IR/G. DRY MUD		4.84E-10	3.17E-11	6.74E-11	2.93E-10							
X DREDGE MATERIAL		0.860	0.000	0.000	0.000							
SAMPLE E		4437	4439	4441	4441							
G. DRY/CC. WET MUD		0.594	0.616	0.543	0.543							
G. IR/G. DRY MUD		-BOL	6.74E-11	1.93E-10	1.93E-10							
X DREDGE MATERIAL		0.000	0.000	0.000	0.000							
SAMPLE F												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
X DREDGE MATERIAL												
SAMPLE G												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
X DREDGE MATERIAL												
SAMPLE H												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
X DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION							
H C	3	59	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		11APR74	8MAY74	5JUN74	19JUL74	7AUG74	4SEP74	11OCT74	22NOV74	17DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)		7.0	6.5	6.0	7.0	6.5	7.0	7.0	6.5	7.0
THICKNESS OF LAYERS (IN)										
FLUFF		1.0	1.5	2.0	0.0	0.0	1.0	1.5	1.0	1.0
ACTIVE		10.0	5.0	9.0	6.0	8.0	6.0	9.0	1.0	8.0
INACTIVE		6.0	12.0	8.0	9.0	4.0	5.0	10.0	18.0	13.0
SAMPLE A		3931	1399	1693	1981	2221	2557	2932	3313	3598
G. DRY/CC. WET MUD		0.677	0.544	0.520	0.625	0.450	0.677	0.492	0.632	0.537
G. IR/G. DRY MUD		3.80E-10	6.92E-10	4.23E-10	7.20E-10	6.74E-11	4.58E-11	8.66E-10	1.81E-09	2.61E-10
Σ DREDGE MATERIAL		0.330	1.930	0.551	2.073	0.000	0.000	2.823	7.636	0.000
SAMPLE B		3932	1400	1694	1982	2222	2558	2933	3314	3599
G. DRY/CC. WET MUD		0.500	0.556	0.481	0.589	0.605	0.641	0.577	0.580	0.440
G. IR/G. DRY MUD		6.75E-10	4.29E-10	1.87E-10	-BDL	2.48E-10	2.80E-10	2.09E-09	3.03E-10	3.91E-11
Σ DREDGE MATERIAL		1.843	0.579	0.000	0.000	0.000	0.000	9.076	0.000	0.000
SAMPLE C		3933	1401	1695	1983	2223	2559	2934	3315	3600
G. DRY/CC. WET MUD		0.557	0.559	0.542	0.685	0.612	0.614	0.603	0.774	0.706
G. IR/G. DRY MUD		-BDL	8.12E-10	2.28E-10	-BDL	4.60E-10	-BDL	4.35E-09	4.78E-10	1.22E-10
Σ DREDGE MATERIAL		0.000	2.544	0.000	0.000	0.737	0.000	20.705	0.819	0.000
SAMPLE D			4442			4780	4444	4446		
G. DRY/CC. WET MUD			0.625			0.616	0.606	0.658		
G. IR/G. DRY MUD			1.08E-10			4.44E-10	2.33E-10	6.34E-10		
Σ DREDGE MATERIAL			0.000			0.657	0.000	1.631		
SAMPLE E							4445	4447		
G. DRY/CC. WET MUD							0.671	0.660		
G. IR/G. DRY MUD							-BDL	5.06E-11		
Σ DREDGE MATERIAL							0.000	0.000		
SAMPLE F			4443							
G. DRY/CC. WET MUD			0.684							
G. IR/G. DRY MUD			-BDL							
Σ DREDGE MATERIAL			0.000							
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES		HOLE NO.	LOCATION											
1 E	5	70	SAN PABLO BAY FLATS (STAKED)											
SAMPLING DATES		12APR74	5MAY74	5JUN74	19JUL74	6AUG74	5SEP74	16OCT74	22NOV74	20DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		7.0	5.5	6.0	7.0	5.5	6.0	6.0	6.0	7.0				
THICKNESS OF LAYERS (IN)														
FLUFF		1.0	2.0	1.0	0.0	1.0	1.0	2.0	0.0	0.0				
ACTIVE		9.0	6.0	10.0	7.0	7.0	5.0	8.0	2.0	3.0				
INACTIVE		10.0	10.0	8.0	11.0	16.0	5.0	10.0	12.0	17.0				
SAMPLE A		1138	1333	1621	1972	2263	2536	2983	3316	3535				
G.DRY/CC.WET MUD		0.240	0.574	0.569	0.591	0.572	0.645	0.425	0.583	0.533				
G.IR/G.DRY MUD		1.39E-09	3.46E-10	2.07E-09	7.61E-10	1.64E-10	2.03E-10	4.26E-10	3.99E-10	1.54E-10				
* DREDGE MATERIAL		5.512	0.153	9.005	2.282	0.000	0.000	0.566	0.428	0.000				
SAMPLE B		1139	1334	1622	1973	2264	2537	2984	3317	3536				
G.DRY/CC.WET MUD		0.616	0.618	0.542	0.539	0.636	0.623	0.595	0.700	0.509				
G.IR/G.DRY MUD		2.11E-09	4.06E-10	1.81E-10	3.45E-10	1.03E-10	1.27E-10	1.19E-09	2.77E-10	4.03E-10				
* DREDGE MATERIAL		9.200	0.461	0.000	0.150	0.000	0.000	4.501	0.000	0.445				
SAMPLE C		1140	1335	1623	1974	2265	2538	2985	3318	3537				
G.DRY/CC.WET MUD		0.600	0.510	0.579	0.533	0.560	0.568	0.597	0.649	0.623				
G.IR/G.DRY MUD		1.03E-09	4.61E-10	8.06E-10	3.45E-10	1.90E-10	9.59E-11	4.34E-10	4.85E-10	3.84E-10				
* DREDGE MATERIAL		3.679	0.744	2.512	0.150	0.000	0.000	0.603	0.869	0.351				
SAMPLE D			0505	4448			4450	4452	4835	4834				
G.DRY/CC.WET MUD			0.622	0.422			0.664	0.591	0.586	0.623				
G.IR/G.DRY MUD			3.62E-10	1.05E-10			8.88E-11	8.29E-11	9.74E-11	2.12E-10				
* DREDGE MATERIAL			0.237	0.000			0.000	0.000	0.000	0.000				
SAMPLE E			0506	4449				4453		4779				
G.DRY/CC.WET MUD			0.647	0.683				0.701		0.650				
G.IR/G.DRY MUD			-80L	3.39E-10				2.18E-10		1.75E-10				
* DREDGE MATERIAL			0.000	0.118				0.000		0.000				
SAMPLE F									4836					
G.DRY/CC.WET MUD									0.575					
G.IR/G.DRY MUD									1.27E-11					
* DREDGE MATERIAL									0.000					
SAMPLE G							4451							
G.DRY/CC.WET MUD							0.770							
G.IR/G.DRY MUD							4.80E-11							
* DREDGE MATERIAL							0.000							
SAMPLE H														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
* DREDGE MATERIAL														

COORDINATES		HOLE NO.	LOCATION									
1 E	4 5	71	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES		12APR74	10MAY74	7JUN74	22JUL74	6AUG74	5SEP74	16OCT74	23NOV74	17DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		7.5	6.0	6.5	6.5	7.0	6.5	6.5	7.0	7.0		
THICKNESS OF LAYERS (IN)												
FLOFF		1.0	1.0	2.0	0.0	0.5	0.0	2.0	0.0	0.0	1.0	
ACTIVE		10.0	8.0	16.0	3.0	14.0	8.0	6.0	2.0	4.0		
INACTIVE		11.0	12.0	5.0	9.0	3.0	3.0	9.0	20.0	12.0		
SAMPLE A		1147	1417	1663	2020	2230	2560	2986	3262	3613		
G.DRY/CC.WET MUD		0.391	0.635	0.629	0.560	0.580	0.805	0.530	0.507	0.613		
G.IR/G.DRY MUD		7.25E-10	5.14E-10	2.38E-10	3.10E-10	2.74E-10	3.77E-10	5.13E-10	4.63E-11	9.94E-10		
Σ DREDGE MATERIAL		2.097	1.013	0.000	0.000	0.000	0.310	1.525	0.000	3.476		
SAMPLE B		1148	1418	1664	2021	2231	2561	2987	3263	3614		
G.DRY/CC.WET MUD		0.587	0.567	0.583	0.537	0.658	0.678	0.562	0.600	0.626		
G.IR/G.DRY MUD		7.69E-10	1.05E-09	2.15E-10	2.42E-10	1.05E-10	8.24E-10	5.67E-10	1.35E-10	2.36E-10		
Σ DREDGE MATERIAL		2.321	3.785	0.000	0.000	0.000	2.604	1.287	0.000	0.000		
SAMPLE C		1149	1419	1665	2022	2232	2562	2988	3264	3615		
G.DRY/CC.WET MUD		0.527	0.643	0.524	0.609	0.657	0.720	0.660	0.702	0.636		
G.IR/G.DRY MUD		5.15E-10	5.90E-10	8.69E-10	1.50E-10	-BDL	3.33E-10	-BDL	3.77E-10	4.70E-10		
Σ DREDGE MATERIAL		1.021	1.406	2.836	0.000	0.000	0.088	0.000	0.313	0.788		
SAMPLE D				4454		4455	4457	4458	4837	4839		
G.DRY/CC.WET MUD				0.679		0.824	0.875	0.689	0.602	0.568		
G.IR/G.DRY MUD				5.45E-10		6.01E-10	-BDL	-BDL	0.00E+00	1.67E-10		
Σ DREDGE MATERIAL				1.175		1.461	0.000	0.000	0.000	0.000		
SAMPLE E						4456		4459		4840		
G.DRY/CC.WET MUD						0.811		0.718		0.589		
G.IR/G.DRY MUD						4.10E-10		-BDL		3.63E-10		
Σ DREDGE MATERIAL						0.482		0.000		0.242		
SAMPLE F												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION									
H	H	4	3	72	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		12APR74	10MAY74	7JUN74	10JUL74	1AUG74	5SEP74	16OCT74	23NOV74	17DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		9.5	8.0	8.0	7.5	10.0	8.0	9.0	9.0	9.0		
THICKNESS OF LAYERS (IN)												
FLUFF		0.5	1.0	1.0	1.5	0.0	1.0	1.0	0.0	1.0		
ACTIVE		13.0	7.0	4.5	9.0	8.0	8.0	6.0	2.0	6.0		
INACTIVE		6.0	9.0	9.0	6.0	4.0	8.0	9.0	20.0	16.0		
SAMPLE A												
G. DRY/CC. WET MUD		1150	1372	1666	1936	2284	2491	2989	3334	3601		
G. IR/G. DRY MUD		0.517	0.629	0.534	0.563	0.740	0.657	0.646	0.424	0.534		
G. IR/G. DRY MUD		7.56E-10	1.43E-09	3.82E-10	1.31E-09	2.82E-10	1.48E-10	3.39E-10	2.45E-10	3.84E-10		
Σ DREDGE MATERIAL		2.258	5.712	0.341	5.123	0.000	0.000	0.118	0.000	0.348		
SAMPLE B												
G. DRY/CC. WET MUD		1151	1373	1667	1937	2285	2492	2990	3335	3602		
G. IR/G. DRY MUD		0.509	0.632	0.577	0.618	0.592	0.610	0.568	0.636	0.597		
G. IR/G. DRY MUD		5.53E-10	1.35E-09	6.24E-10	9.85E-10	5.83E-10	2.14E-10	2.71E-10	4.45E-10	2.86E-10		
Σ DREDGE MATERIAL		1.216	5.282	1.579	3.431	1.368	0.000	0.000	0.000	0.000		
SAMPLE C												
G. DRY/CC. WET MUD		1152	1374	1668	1938	2286	2493	2991	3336	3603		
G. IR/G. DRY MUD		0.587	0.526	0.549	0.558	0.549	0.609	0.587	0.581	0.489		
G. IR/G. DRY MUD		1.31E-09	4.20E-10	1.05E-09	7.84E-10	1.61E-10	1.76E-10	-BDL-	1.60E-10	3.57E-10		
Σ DREDGE MATERIAL		5.095	0.531	3.742	2.399	0.000	0.000	0.000	0.000	0.211		
SAMPLE D												
G. DRY/CC. WET MUD		4650		4460	4462							
G. IR/G. DRY MUD		0.570		0.577	0.566							
G. IR/G. DRY MUD		2.46E-10		2.49E-10	1.20E-10							
Σ DREDGE MATERIAL		0.000		0.000	0.000							
SAMPLE E												
G. DRY/CC. WET MUD				4461								
G. IR/G. DRY MUD				0.634								
G. IR/G. DRY MUD				-BDL-								
Σ DREDGE MATERIAL				0.000								
SAMPLE F												
G. DRY/CC. WET MUD		4651										
G. IR/G. DRY MUD		0.592										
G. IR/G. DRY MUD		2.93E-10										
Σ DREDGE MATERIAL		0.000										
SAMPLE G												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
G. IR/G. DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G. DRY/CC. WET MUD												
G. IR/G. DRY MUD												
G. IR/G. DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION											
G E	3 5	73	SAN PABLO STRAIT											
SAMPLING DATES		24APR74	20MAY74	20JUN74	10JUL74	23AUG74	28SEP74	8OCT74	4NOV74	30DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		24.5	32.0	26.0	25.0	25.0	25.0	25.0	25.5	25.0				
THICKNESS OF LAYERS (IN)														
FLUFF		3.0	1.0	4.0	9.0	2.0	3.0	2.0	0.0	0.0				
ACTIVE		7.0	5.0	10.0	8.0	8.0	12.0	7.0	12.0	2.0				
INACTIVE		8.0	11.0	6.0	4.0	8.0	6.0	8.0	6.0	21.0				
SAMPLE A		1273	1552	1816	1942	2446	2731	2956	3109	3541				
G.DRY/CC.WET MUD		0.336	0.784	0.604	0.586	0.650	0.757	0.511	0.456	0.546				
G.1R/G.DRY MUD		1.06E-09	4.61E-10	3.00E-10	1.96E-08	7.68E-10	3.90E-10	3.59E-09	1.19E-10	3.38E-10				
* DREDGE MATERIAL		3.830	0.746	0.000	98.935	2.316	0.380	16.817	0.000	0.115				
SAMPLE B		1274	1553	1817	1943	2447	2732	2957	3110	3542				
G.DRY/CC.WET MUD		0.538	0.610	0.463	0.584	0.513	0.512	0.462	0.468	0.487				
G.1R/G.DRY MUD		4.46E-10	1.93E-10	5.24E-10	6.00E-09	3.71E-10	3.90E-10	1.29E-09	2.09E-10	9.78E-11				
* DREDGE MATERIAL		0.667	0.000	1.067	29.143	0.284	0.380	5.001	0.000	0.000				
SAMPLE C		1275	1554	1819	1944	2448	2733	2958	3111	3543				
G.DRY/CC.WET MUD		0.521	0.615	0.433	0.567	0.550	0.601	0.615	0.555	0.511				
G.1R/G.DRY MUD		4.03E-10	3.73E-10	1.77E-10	3.19E-09	3.60E-10	1.78E-10	1.31E-09	2.27E-10	-80L-				
* DREDGE MATERIAL		0.447	0.294	0.000	14.717	0.224	0.000	5.090	0.000	0.000				
SAMPLE D				4883	4463	4685								
G.DRY/CC.WET MUD				0.616	0.569	0.603								
G.1R/G.DRY MUD				4.79E-10	1.64E-10	1.80E-10								
* DREDGE MATERIAL				0.837	0.000	0.000								
SAMPLE E				4884	4464									
G.DRY/CC.WET MUD				0.549	0.587									
G.1R/G.DRY MUD				6.81E-10	7.84E-10									
* DREDGE MATERIAL				1.870	2.398									
SAMPLE F					0510									
G.DRY/CC.WET MUD					0.583									
G.1R/G.DRY MUD					1.25E-10									
* DREDGE MATERIAL					0.000									
SAMPLE G														
G.DRY/CC.WET MUD														
G.1R/G.DRY MUD														
* DREDGE MATERIAL														
SAMPLE H														
G.DRY/CC.WET MUD														
G.1R/G.DRY MUD														
* DREDGE MATERIAL														

COORDINATES		HOLE NO.		LOCATION											
H	E	3	5	74	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES				15APR74	10MAY74	6JUN74	10JUL74	1AUG74	5SEP74	16OCT74	12NOV74	16DEC74			
DEPTH OF SEDIMENT BELOW MLLW (FT)				11.0	9.0	10.0	9.5	11.0	10.5	11.0	11.0	10.5			
THICKNESS OF LAYERS (IN)				0.5	1.0	1.0	2.0	0.0	0.0	2.0	1.0	1.0			
FLUFF				6.0	6.0	8.5	8.0	6.0	10.0	4.0	11.0	4.0			
ACTIVE				6.0	8.0	9.0	7.0	10.0	4.0	14.0	16.0	17.0			
INACTIVE															
SAMPLE A				1135	1447	1633	1930	2287	2494	2992	3154	3586			
G. DRY/CC.WET MUD				0.332	0.485	0.589	0.547	0.631	0.635	0.571	0.503	0.516			
G. IR/G.DRY MUD				7.91E-10	2.89E-10	3.78E-10	2.47E-10	7.48E-10	7.38E-10	9.02E-10	1.11E-10	2.60E-10			
Σ DREDGE MATERIAL				2.436	0.000	0.318	0.000	2.213	2.165	3.004	0.000	0.000			
SAMPLE B				1136	1448	1634	1931	2288	2495	2993	3155	3587			
G. DRY/CC.WET MUD				0.510	0.572	0.539	0.564	0.605	0.615	0.551	0.525	0.591			
G. IR/G.DRY MUD				9.42E-10	5.38E-10	3.58E-10	3.48E-10	3.65E-10	2.03E-10	5.33E-10	7.72E-11	-BOL-			
Σ DREDGE MATERIAL				3.210	1.138	0.216	0.164	0.250	0.000	1.113	0.000	0.000			
SAMPLE C				1137	1449	1635	1932	2289	2496	2994	3156	3588			
G. DRY/CC.WET MUD				0.560	0.542	0.570	0.598	0.522	0.571	0.633	0.697	0.678			
G. IR/G.DRY MUD				1.20E-09	-BOL-	2.59E-10	1.50E-10	2.73E-10	3.73E-10	2.16E-10	2.36E-10	7.81E-10			
Σ DREDGE MATERIAL				4.532	0.000	0.000	0.000	0.000	0.295	0.000	0.000	2.384			
SAMPLE D				4533											
G. DRY/CC.WET MUD				0.561											
G. IR/G.DRY MUD				-BOL-											
Σ DREDGE MATERIAL				0.000											
SAMPLE E				4534											
G. DRY/CC.WET MUD				0.377											
G. IR/G.DRY MUD				-BOL-											
Σ DREDGE MATERIAL				0.000											
SAMPLE F															
G. DRY/CC.WET MUD															
G. IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE G															
G. DRY/CC.WET MUD															
G. IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE H															
G. DRY/CC.WET MUD															
G. IR/G.DRY MUD															
Σ DREDGE MATERIAL															

COORDINATES		HOLE LOCATION											
B D 13 8		NO. 75		SUITSUN BAY									
SAMPLING DATES		16APR74		17JUN74	29JUL74	13AUG74	11SEP74	10OCT74	14NOV74	11DEC74			
DEPTH OF SEDIMENT BELOW MLLW (FT)		12.0	16.0	18.0	16.0	16.0	15.5	15.5	17.0	16.0			
THICKNESS OF FLUFF LAYERS (IN)		0.0	2.0	1.5	2.0	1.0	1.0	2.0	0.0	0.0			
ACTIVE		8.0	12.0	8.0	5.0	7.0	9.0	9.0	8.0	3.0			
INACTIVE		10.0	3.0	3.0	7.0	12.0	3.0	2.0	10.0	21.0			
SAMPLE A		1120	1423	1798	2164	2302	2578	2905	3202	3646			
G.DRY/CC.WET MUD		0.456	0.432	0.591	0.406	0.454	0.688	0.691	0.344	0.456			
G.IR/G.DRY MUD		1.08E-09	9.64E-10	4.72E-10	1.31E-09	-BOL-	4.02E-10	6.05E-10	2.74E-10	3.65E-10			
* DREDGE MATERIAL		3.944	3.324	0.801	5.075	0.000	0.442	1.483	0.000	0.253			
SAMPLE B		1121	1424	1799	2165	2303	2579	2906	3203	3647			
G.DRY/CC.WET MUD		0.524	0.717	0.626	0.610	0.565	0.543	0.539	0.593	0.620			
G.IR/G.DRY MUD		1.33E-09	5.45E-10	1.96E-10	-BOL-	9.35E-10	5.38E-10	4.61E-10	5.59E-10	2.16E-10			
* DREDGE MATERIAL		5.192	1.173	0.000	0.000	3.174	1.137	0.743	1.244	0.000			
SAMPLE C		1122	1425	1800	2166	2304	2580	2907	3204	3648			
G.DRY/CC.WET MUD		0.588	0.683	0.570	0.635	0.525	0.673	0.723	0.680	0.642			
G.IR/G.DRY MUD		1.13E-09	1.02E-09	3.28E-10	2.05E-10	3.28E-10	3.16E-11	-BOL-	-BOL-	2.00E-10			
* DREDGE MATERIAL		4.169	3.618	0.063	0.000	0.061	0.000	0.000	0.000	0.000			
SAMPLE D		4535	4470				4472						
G.DRY/CC.WET MUD		0.421	0.730				0.660						
G.IR/G.DRY MUD		2.36E-10	2.65E-10				4.28E-12						
* DREDGE MATERIAL		0.000	0.000				0.000						
SAMPLE E		4536	4471										
G.DRY/CC.WET MUD		0.564	0.673										
G.IR/G.DRY MUD		2.17E-10	2.35E-10										
* DREDGE MATERIAL		0.000	0.000										
SAMPLE F		0504											
G.DRY/CC.WET MUD		0.625											
G.IR/G.DRY MUD		4.97E-10											
* DREDGE MATERIAL		0.926											
SAMPLE G													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													

COORDINATES		HOLE NO.	LOCATION									
B E 15 5		76	SUISUN BAY									
SAMPLING DATES		16APR74	16MAY74	17JUN74	29JUL74	13AUG74	11SEP74	10OCT74	13NOV74	11DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		23.0	18.5	18.5	19.0	18.0	18.0	19.0	19.0	18.5		
THICKNESS OF LAYERS (IN)												
FLUFF	0.0	1.5	2.5	0.0	0.0	0.0	0.0	3.0	0.0	0.0		
ACTIVE	7.0	6.0	7.0	6.0	10.0	10.0	10.0	11.0	9.0	2.0		
INACTIVE	8.0	6.0	14.0	6.0	1.0	8.0	8.0	8.0	12.0	22.0		
SAMPLE A		1123	1489	1801	2161	2305	2581	2908	3211	3643		
G.DRY/CC.WET MUD	1.174	0.809	0.851	0.847	1.538	0.732	0.413	0.459	0.459	0.979		
G.IR/G.DRY MUD	1.36E-09	3.28E-10	3.28E-10	1.74E-10	2.49E-10	3.61E-10	5.57E-10	6.14E-09	1.94E-10	1.94E-10		
Σ DREDGE MATERIAL	5.344	0.063	0.063	0.000	0.000	0.233	1.235	29.847	0.000	0.000		
SAMPLE B		1124	1490	1802	2162	2306	2582	2909	3212	3644		
G.DRY/CC.WET MUD	1.068	0.789	1.094	1.083	1.460	0.759	0.538	0.753	0.753	0.586		
G.IR/G.DRY MUD	1.20E-09	1.38E-10	1.22E-10	4.23E-10	3.45E-10	5.23E-10	4.96E-10	-BDL	-BDL	2.05E-10		
Σ DREDGE MATERIAL	4.550	0.000	0.000	0.549	0.147	1.062	0.924	0.000	0.000	0.000		
SAMPLE C		1125	1491	1803	2163	2307	2583	2910	3213	3645		
G.DRY/CC.WET MUD	0.784	0.718	0.841	0.779	1.139	0.565	0.581	1.044	1.044	0.669		
G.IR/G.DRY MUD	1.24E-09	2.54E-10	6.08E-10	1.12E-10	4.40E-10	2.71E-10	6.75E-10	1.43E-10	-BDL	-BDL		
Σ DREDGE MATERIAL	4.749	0.000	1.499	0.000	0.636	0.000	1.843	0.000	0.000	0.000		
SAMPLE D		4541	4473	4473	4473	4473	4473	4473	4473	4473		
G.DRY/CC.WET MUD	0.636	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.669		
G.IR/G.DRY MUD	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL		
Σ DREDGE MATERIAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
SAMPLE E		4542	4474	4474	4474	4474	4474	4474	4474	4474		
G.DRY/CC.WET MUD	0.261	0.753	0.753	0.753	0.753	0.753	0.753	0.753	0.753	0.669		
G.IR/G.DRY MUD	2.89E-10	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	-BDL		
Σ DREDGE MATERIAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
SAMPLE F		4543	4475	4475	4475	4475	4475	4475	4475	4475		
G.DRY/CC.WET MUD	0.636	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.669		
G.IR/G.DRY MUD	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL	-BDL		
Σ DREDGE MATERIAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
SAMPLE G		4544	4476	4476	4476	4476	4476	4476	4476	4476		
G.DRY/CC.WET MUD	0.261	0.753	0.753	0.753	0.753	0.753	0.753	0.753	0.753	0.669		
G.IR/G.DRY MUD	2.89E-10	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	-BDL		
Σ DREDGE MATERIAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
SAMPLE H		4545	4477	4477	4477	4477	4477	4477	4477	4477		
G.DRY/CC.WET MUD	0.261	0.753	0.753	0.753	0.753	0.753	0.753	0.753	0.753	0.669		
G.IR/G.DRY MUD	2.89E-10	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	7.32E-11	-BDL		
Σ DREDGE MATERIAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

COORDINATES		HOLE	LOCATION											
B E 16 5		NO. 77	SUISUN BAY											
SAMPLING DATES		16APR74	28MAY74	17JUN74	29JUL74	13AUG74	11SEP74	10OCT74	13NOV74	11DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		14.0	9.0	10.5	11.0	11.0	12.0	11.0	10.5	11.0				
THICKNESS OF LAYERS (IN)														
FLUFF		0.0	2.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0				
ACTIVE		10.0	5.0	8.0	4.0	15.0	8.0	4.0	13.0	10.0				
INACTIVE		0.0	15.0	7.0	10.0	0.0	9.0	7.0	0.0	10.0				
SAMPLE A		1141	1576	1792	2143	2335	2584	2911	3181	3547				
G. DRY/CC. WET MUD		1.154	0.953	1.061	0.884	0.836	0.627	0.654	0.725	0.930				
G. IR/G. DRY MUD		1.00E-09	4.07E-10	1.40E-10	2.98E-10	2.92E-10	4.81E-10	7.27E-10	2.02E-10	-BOL-				
Σ DREDGE MATERIAL		3.525	0.466	0.000	0.000	0.000	0.846	2.107	0.000	0.000				
SAMPLE B		1142	1577	1793	2144	2336	2585	2912	3182	3548				
G. DRY/CC. WET MUD		1.337	1.093	0.879	0.996	1.114	0.759	1.164	1.069	0.869				
G. IR/G. DRY MUD		6.13E-10	1.21E-10	2.56E-10	3.77E-10	1.25E-11	2.57E-09	3.58E-10	7.39E-11	4.62E-10				
Σ DREDGE MATERIAL		1.522	0.000	0.000	0.312	0.000	11.578	0.217	0.000	0.749				
SAMPLE C		1143	1578	1794	2145	2337	2586	2913	3183	3549				
G. DRY/CC. WET MUD		1.277	0.848	0.977	0.919	1.054	0.824	1.291	1.165	0.869				
G. IR/G. DRY MUD		6.00E-10	3.67E-10	7.84E-11	4.69E-10	2.97E-10	2.99E-10	4.13E-10	9.24E-11	1.66E-11				
Σ DREDGE MATERIAL		1.459	0.260	0.000	0.783	0.000	0.000	0.497	0.000	0.000				
SAMPLE D														
G. DRY/CC. WET MUD		4479												
G. IR/G. DRY MUD		0.646												
Σ DREDGE MATERIAL		3.96E-10												
SAMPLE E														
G. DRY/CC. WET MUD		4478												
G. IR/G. DRY MUD		0.675												
Σ DREDGE MATERIAL		2.83E-11												
SAMPLE F														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE G														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														

COORDINATES			HOLE NO.	LOCATION									
B E 17 5			78	SUISUN BAY (STAKED)									
SAMPLING DATES			16APR74	28MAY74	17JUN74	29JUL74	13AUG74	11SEP74	10OCT74	13NOV74	11DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)			4.0	5.0	4.5	4.0	5.0	5.0	4.5	4.0	4.0		
THICKNESS OF LAYERS (IN)													
FLUFF			2.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0	0.0		
ACTIVE			5.0	10.0	6.0	7.0	7.0	4.0	8.0	7.0	4.0		
INACTIVE			9.0	8.0	15.0	10.0	10.0	7.0	8.0	19.0	11.0		
SAMPLE A			1159	1579	1804	2116	2308	2587	2914	3199	3394		
G.DRY/CC.WET MUD			0.854	1.124	1.076	0.700	0.983	0.838	0.783	0.582	0.797		
G.IR/G.DRY MUD			1.02E-09	1.54E-10	7.46E-10	-BDL	1.32E-10	4.85E-10	3.08E-10	1.22E-10	1.72E-09		
* DREDGE MATERIAL			3.629	0.000	2.203	0.000	0.000	0.868	0.000	0.000	7.203		
SAMPLE B			1160	1580	1805	2117	2309	2588	2915	3200	3395		
G.DRY/CC.WET MUD			0.893	1.179	1.097	1.077	1.160	1.322	0.941	1.039	1.253		
G.IR/G.DRY MUD			1.00E-09	1.82E-10	2.28E-10	-BDL	4.95E-10	-BDL	1.56E-10	1.09E-10	3.47E-10		
* DREDGE MATERIAL			3.520	0.000	0.000	0.000	0.918	0.000	0.000	0.000	0.158		
SAMPLE C			1161	1581	1806	2118	2310	2589	2916	3201	3396		
G.DRY/CC.WET MUD			1.147	0.888	0.912	1.098	0.887	0.626	1.010	1.079	1.040		
G.IR/G.DRY MUD			6.17E-10	1.31E-10	1.12E-10	1.47E-10	3.37E-10	3.03E-10	-BDL	1.92E-10	2.65E-10		
* DREDGE MATERIAL			1.543	0.000	0.000	0.000	0.108	0.000	0.000	0.000	0.000		
SAMPLE D			4539										
G.DRY/CC.WET MUD			1.045										
G.IR/G.DRY MUD			9.08E-11										
* DREDGE MATERIAL			0.000										
SAMPLE E			4540										
G.DRY/CC.WET MUD			0.626										
G.IR/G.DRY MUD			2.82E-10										
* DREDGE MATERIAL			0.000										
SAMPLE F													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													
SAMPLE G													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
* DREDGE MATERIAL													

COORDINATES		HOLE		LOCATION						
1 C 7 B		NO. 79		SAN PABLO BAY FLATS (STAKED)						
SAMPLING DATES		17APR74	5MAV74	13JUN74	26JUL74	8AUG74	9SEP74	20CT74	1NOV74	2DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		2.5	3.0	2.5	1.5	2.0	3.0	2.5	3.0	2.5
THICKNESS OF LAYERS (IN)		2.0	1.0	1.5	1.0	1.0	1.0	1.0	0.0	0.0
FLUFF		10.0	8.0	9.0	7.0	10.0	8.0	10.0	13.0	2.0
ACTIVE		6.0	7.0	7.0	6.0	7.0	11.0	9.0	2.0	22.0
INACTIVE										
SAMPLE A		1339	1732	2110	2368	2563	2779	3079	3484	
G. DRY/CC. WET MUD		0.758	0.847	0.623	1.051	0.755	0.837	0.511	0.831	0.0
G. IR/G. DRY MUD		5.90E-10	9.35E-11	1.92E-10	1.31E-11	1.33E-10	5.18E-10	5.03E-10	4.34E-10	0.0
Σ DREDGE MATERIAL		1.407	0.000	0.000	0.000	0.000	1.033	0.960	0.607	0.0
SAMPLE B		1340	1733	2111	2369	2564	2780	3080	3485	
G. DRY/CC. WET MUD		0.586	0.615	0.682	0.643	0.673	0.622	0.631	0.536	0.0
G. IR/G. DRY MUD		4.43E-10	4.94E-10	6.60E-10	3.77E-10	3.95E-10	1.80E-10	2.12E-10	1.70E-10	0.0
Σ DREDGE MATERIAL		0.651	0.913	1.763	0.313	0.406	0.000	0.000	0.000	0.0
SAMPLE C		1341	1734	2112	2370	2565	2781	3081	3486	
G. DRY/CC. WET MUD		0.613	0.625	0.712	0.645	0.563	0.631	0.675	0.625	0.0
G. IR/G. DRY MUD		7.99E-10	4.45E-12	4.91E-10	2.05E-11	2.38E-09	1.12E-10	1.08E-09	4.48E-10	0.0
Σ DREDGE MATERIAL		2.478	0.000	0.899	0.000	10.604	0.000	3.920	0.678	0.0
SAMPLE D		4644		4776	4482	4480	4774	4772		
G. DRY/CC. WET MUD		0.749		0.684	0.644	0.600	0.663	0.682		
G. IR/G. DRY MUD		-BOL -		1.28E-10	-BOL -	-BOL -	2.48E-10	2.72E-10		
Σ DREDGE MATERIAL		0.000		0.000	0.000	0.000	0.000	0.000		
SAMPLE E		4645			4483	4481	4775	4773		
G. DRY/CC. WET MUD		0.635			0.687	0.670	0.695	0.755		
G. IR/G. DRY MUD		1.41E-10			5.06E-10	-BOL -	3.39E-10	1.90E-10		
Σ DREDGE MATERIAL		0.000			0.975	0.000	0.117	0.000		
SAMPLE F				4777						
G. DRY/CC. WET MUD				0.757						
G. IR/G. DRY MUD				3.64E-10						
Σ DREDGE MATERIAL				0.244						
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES			HOLE NO.	LOCATION										
J	E	7	5	80	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES					17APR74	23MAY74	13JUN74	26JUL74	15AUG74	9SEP74	30CT74	1NOV74	2DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)					1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	
THICKNESS OF LAYERS (IN)					1.5	2.0	4.0	1.0	1.0	1.0	1.0	0.0	0.0	
FLUFF					8.0	8.0	9.0	10.0	9.0	12.0	8.0	17.0	3.0	
ACTIVE					11.0	7.0	8.0	6.0	3.0	5.0	7.0	6.0	18.0	
INACTIVE														
SAMPLE A					1171	1543	1756	2098	2359	2614	2830	3082	3568	
G.DRY/CC.WET MUD					0.569	0.813	0.678	0.663	0.750	0.777	0.886	0.738	0.742	
G.IR/G.DRY MUD					1.05E-09	3.74E-10	3.85E-10	2.76E-10	2.78E-10	1.51E-10	1.54E-10	2.76E-10	3.48E-10	
Σ DREDGE MATERIAL					3.772	0.298	0.356	0.000	0.000	0.000	0.000	0.000	0.162	
SAMPLE B					1172	1544	1757	2099	2360	2615	2831	3083	3569	
G.DRY/CC.WET MUD					0.637	0.708	0.623	0.662	0.645	0.661	0.615	0.692	0.628	
G.IR/G.DRY MUD					8.40E-10	3.17E-10	4.14E-10	3.17E-10	5.10E-10	1.33E-10	2.01E-10	3.34E-10	2.66E-10	
Σ DREDGE MATERIAL					2.686	0.007	0.501	0.006	0.997	0.000	0.000	0.095	0.000	
SAMPLE C					1173	1545	1758	2100	2361	2616	2832	3084	3570	
G.DRY/CC.WET MUD					0.656	0.742	0.718	0.712	0.784	0.690	0.714	0.701	0.686	
G.IR/G.DRY MUD					7.32E-10	3.72E-10	3.35E-10	6.36E-10	1.21E-10	-BDL	5.56E-11	1.42E-10	6.38E-10	
Σ DREDGE MATERIAL					2.133	0.286	0.097	1.643	0.000	0.000	0.000	0.000	1.652	
SAMPLE D					4484			4486					4841	
G.DRY/CC.WET MUD					0.580			0.654					0.770	
G.IR/G.DRY MUD					1.45E-10			0.00E+00					2.69E-10	
Σ DREDGE MATERIAL					0.000			0.000					0.000	
SAMPLE E					4485			4487						
G.DRY/CC.WET MUD					0.662			0.627						
G.IR/G.DRY MUD					4.62E-10			6.40E-11						
Σ DREDGE MATERIAL					0.749			0.000						
SAMPLE F													4842	
G.DRY/CC.WET MUD													0.555	
G.IR/G.DRY MUD													4.86E-10	
Σ DREDGE MATERIAL													0.870	
SAMPLE G														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H														
G.DRY/CC.WET MUD														
G.IR/G.DRY MUD														
Σ DREDGE MATERIAL														

COORDINATES		HOLE NO.	LOCATION					
J E	5	81	SAN PABLO BAY FLATS (STAKED)					
SAMPLING DATES		17APR74	22MAY74	13JUN74	26JUL74	8AUG74	9SEP74	30OCT74
DEPTH OF SEDIMENT BELOW MLLW (FT)		3.0	3.0	3.0	2.5	2.0	3.0	3.0
THICKNESS OF LAYERS (IN)								
FLUFF		2.0	2.5	4.5	1.0	1.0	1.0	1.0
ACTIVE		6.0	8.0	6.0	8.0	10.0	7.0	8.0
INACTIVE		11.0	8.0	6.0	6.0	9.0	7.0	5.0
SAMPLE A		1174	1558	1741	2113	2371	2617	2938
G. DRY/CC. WET MUD		0.406	0.584	0.635	0.562	0.685	0.591	0.626
G. IR/G. DRY MUD		1.24E-09	2.65E-10	3.41E-10	-BDL	4.47E-10	8.84E-12	3.28E-09
Σ DREDGE MATERIAL		4.721	0.000	0.130	0.000	0.670	0.000	15.208
SAMPLE B		1175	1559	1742	2114	2372	2618	2939
G. DRY/CC. WET MUD		0.632	0.528	0.652	0.603	0.637	0.635	0.592
G. IR/G. DRY MUD		9.89E-10	2.42E-10	1.30E-10	3.98E-10	8.40E-10	-BDL	9.54E-10
Σ DREDGE MATERIAL		3.454	0.000	0.000	0.419	2.687	0.000	3.270
SAMPLE C		1176	1560	1743	2115	2373	2619	2940
G. DRY/CC. WET MUD		0.653	0.727	0.592	0.644	0.660	1.121	0.696
G. IR/G. DRY MUD		9.31E-10	2.74E-10	3.36E-10	4.07E-11	1.19E-10	-BDL	3.77E-09
Σ DREDGE MATERIAL		3.154	0.000	0.103	0.000	0.000	0.000	17.737
SAMPLE D		4488						
G. DRY/CC. WET MUD		0.776						
G. IR/G. DRY MUD		2.69E-10						
Σ DREDGE MATERIAL		0.000						
SAMPLE E		4489						
G. DRY/CC. WET MUD		0.784						
G. IR/G. DRY MUD		1.19E-10						
Σ DREDGE MATERIAL		0.000						
SAMPLE F								
G. DRY/CC. WET MUD								
G. IR/G. DRY MUD								
Σ DREDGE MATERIAL								
SAMPLE G								
G. DRY/CC. WET MUD								
G. IR/G. DRY MUD								
Σ DREDGE MATERIAL								
SAMPLE H								
G. DRY/CC. WET MUD								
G. IR/G. DRY MUD								
Σ DREDGE MATERIAL								

COORDINATES		HOLE NO.	LOCATION							
K	E	5	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES			17APR74	23MAY74	18JUN74	15AUG74	12SEP74	30CT74	12NOV74	20DEC74
DEPTH OF SEDIMENT BELOW MLW (FT)			1.5	2.0	2.0	2.5	2.5	2.5	2.5	2.0
THICKNESS OF LAYERS (IN)										
FLUFF			2.0	2.0	2.5	0.5	1.0	1.0	0.0	0.0
ACTIVE			9.0	9.0	8.0	9.0	8.0	4.0	8.0	3.0
INACTIVE			6.0	10.0	6.0	5.0	6.0	12.0	18.0	18.0
SAMPLE A			1201	1564	1837	1912	2317	2632	2833	3157
G. DRY/CC. WET MUD			0.496	0.595	0.679	0.643	0.683	0.721	0.810	0.572
G. IR/G. DRY MUD			1.83E-09	3.77E-10	5.06E-10	3.77E-10	7.10E-10	2.58E-10	2.57E-10	2.69E-11
X DREDGE MATERIAL			7.763	0.315	0.974	0.316	0.000	2.020	0.000	0.000
SAMPLE B			1202	1565	1838	1913	2318	2633	2834	3158
G. DRY/CC. WET MUD			0.589	0.458	0.680	0.603	0.707	0.632	0.613	0.704
G. IR/G. DRY MUD			1.36E-09	4.56E-10	1.61E-10	4.28E-10	3.08E-10	4.97E-10	2.57E-10	5.49E-11
X DREDGE MATERIAL			5.369	0.716	0.000	0.575	0.000	0.930	0.000	1.195
SAMPLE C			1203	1566	1839	1914	2319	2634	2835	3159
G. DRY/CC. WET MUD			0.638	0.596	0.701	0.743	0.689	0.746	0.694	0.644
G. IR/G. DRY MUD			1.33E-09	3.04E-10	2.64E-10	3.84E-10	3.25E-10	3.37E-10	1.66E-10	-BDL-
X DREDGE MATERIAL			5.198	0.000	0.000	0.348	0.047	0.107	0.000	0.000
SAMPLE D			4491							
G. DRY/CC. WET MUD			0.760							
G. IR/G. DRY MUD			2.47E-10							
X DREDGE MATERIAL			0.000							
SAMPLE E			4492							
G. DRY/CC. WET MUD			0.712							
G. IR/G. DRY MUD			-BDL-							
X DREDGE MATERIAL			0.000							
SAMPLE F										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
X DREDGE MATERIAL										
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
X DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
X DREDGE MATERIAL										

COORDINATES		HOLE NO.	LOCATION							
K E 5	5	83	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		17APR74	23MAY74	18JUN74	18JUL74	8AUG74	12SEP74	30CT74	12NOV74	20DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		2.5	2.5	3.0	3.0	2.0	2.5	2.5	2.5	3.5
THICKNESS OF LAYERS (IN)										
FLUFF		1.5	1.0	3.0	1.0	1.0	1.0	1.0	0.0	0.0
ACTIVE		7.0	10.0	9.0	6.0	9.0	9.0	6.0	10.0	3.0
INACTIVE		7.0	4.0	10.0	6.0	5.0	7.0	13.0	17.0	22.0
SAMPLE A		1189	1498	1807	1924	2374	2635	2836	3160	3574
G. DRY/CC. WET MUD		0.509	0.535	0.785	0.587	0.649	0.705	0.535	0.601	0.581
G. IR/G. DRY MUD		5.77E-10	2.50E-10	4.54E-10	2.83E-10	4.20E-12	2.60E-10	4.94E-10	1.44E-10	-BDL -
DREDGE MATERIAL		1.341	0.000	0.710	0.000	0.000	0.000	0.913	0.000	0.000
SAMPLE B		1190	1499	1808	1925	2375	2636	2837	3161	3575
G. DRY/CC. WET MUD		0.641	0.582	0.646	0.664	0.682	0.645	0.523	0.629	0.571
G. IR/G. DRY MUD		6.22E-10	8.41E-10	4.12E-10	2.18E-10	3.11E-10	-BDL -	4.14E-10	1.47E-10	-BDL -
DREDGE MATERIAL		1.569	2.691	0.492	0.000	0.000	0.000	0.502	0.000	0.000
SAMPLE C		1191	1500	1809	1926	2376	2637	2838	3162	3576
G. DRY/CC. WET MUD		0.698	0.642	0.694	0.570	0.674	0.775	0.764	0.804	0.598
G. IR/G. DRY MUD		5.91E-10	2.37E-09	3.99E-10	3.12E-10	2.06E-10	2.27E-10	-BDL -	5.57E-10	3.77E-10
DREDGE MATERIAL		1.412	10.512	0.427	0.000	0.000	0.000	0.000	1.238	0.314
SAMPLE D			4493	4494					4845	
G. DRY/CC. WET MUD			0.860	0.628					0.778	
G. IR/G. DRY MUD			8.14E-11	3.31E-10					1.29E-10	
DREDGE MATERIAL			0.000	0.075					0.000	
SAMPLE E				4495						
G. DRY/CC. WET MUD				0.659						
G. IR/G. DRY MUD				2.06E-10						
DREDGE MATERIAL				0.000						
SAMPLE F										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
DREDGE MATERIAL										
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
DREDGE MATERIAL										

COORDINATES		HOLE NO.		LOCATION							
K	E	4	5	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		17APR74	23MAY74	18JUN74	18JUL74	15AUG74	12SEP74	30CT74	12NOV74	9DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		2.0	2.5	4.0	3.5	3.5	4.0	3.5	3.0	3.5	
THICKNESS OF LAYERS (IN)		2.0	1.0	3.0	1.0	1.5	1.0	1.0	1.0	1.0	
FLUFF		8.0	7.0	4.0	6.0	9.0	7.0	6.0	9.0	4.0	
ACTIVE		7.0	9.0	8.0	6.0	7.0	6.0	10.0	16.0	15.0	
INACTIVE											
SAMPLE A		1177	1561	1831	1921	2362	2593	2782	3163	3427	
G. DRY/CC. WET MUD		0.588	0.595	0.814	0.695	0.864	0.636	0.898	0.701	0.594	
G. IR/G. DRY MUD		1.22E-09	3.03E-10	2.93E-10	3.40E-10	-BDL	-BDL	5.26E-10	6.61E-11	1.95E-09	
* DREDGE MATERIAL		4.615	0.000	0.000	0.124	0.000	0.000	1.080	0.000	8.393	
SAMPLE B		1178	1562	1832	1922	2363	2594	2783	3164	3428	
G. DRY/CC. WET MUD		0.659	0.634	0.677	0.782	0.654	0.687	0.600	0.595	0.534	
G. IR/G. DRY MUD		7.08E-10	4.93E-10	2.97E-10	2.18E-10	6.68E-11	6.75E-10	3.02E-10	9.03E-11	2.69E-10	
* DREDGE MATERIAL		2.012	0.906	0.000	0.000	0.000	1.839	0.000	0.000	0.000	
SAMPLE C		1179	1563	1833	1923	2364	2595	2784	3165	3429	
G. DRY/CC. WET MUD		0.607	0.624	0.667	0.823	0.601	0.673	0.678	0.723	0.711	
G. IR/G. DRY MUD		1.55E-09	3.41E-10	4.37E-10	5.89E-10	7.87E-11	3.76E-10	1.04E-10	6.69E-11	4.56E-10	
* DREDGE MATERIAL		6.309	0.129	0.621	1.398	0.000	0.308	0.000	0.000	0.718	
SAMPLE D		4496	4498								
G. DRY/CC. WET MUD		0.653	0.749								
G. IR/G. DRY MUD		8.62E-11	2.53E-10								
* DREDGE MATERIAL		0.000	0.000								
SAMPLE E		4497	4499								
G. DRY/CC. WET MUD		0.649	0.743								
G. IR/G. DRY MUD		7.11E-10	1.62E-10								
* DREDGE MATERIAL		2.024	0.000								
SAMPLE F											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
* DREDGE MATERIAL											
SAMPLE G											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
* DREDGE MATERIAL											
SAMPLE H											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
* DREDGE MATERIAL											

COORDINATES		HOLE NO.	LOCATION								
J E 5	5	85	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES		17APR74	23MAY74	13JUN74	26JUL74	8AUG74	5SEP74	30CT74	22NOV74	20DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.0	4.0	3.0	2.5	2.5	3.0	3.5	3.0	5.0	
THICKNESS OF LAYERS (IN)											
FLUFF		1.5	2.0	2.0	1.0	1.0	1.0	1.0	0.0	0.0	
ACTIVE		7.0	8.0	6.0	7.0	11.0	12.0	7.0	5.0	3.0	
INACTIVE		8.0	7.0	9.0	7.0	3.0	7.0	10.0	14.0	20.0	
SAMPLE A		1198	1510	1750	2101	2377	2539	2941	3322	3523	
G.DRY/CC.WET MUD		0.521	0.616	0.600	0.489	0.639	0.577	0.535	0.617	0.602	
G.IR/G.DRY MUD		1.30E-09	6.63E-10	2.61E-10	3.79E-10	4.68E-10	5.93E-10	5.72E-09	3.66E-10	1.14E-10	
Σ DREDGE MATERIAL		5.054	1.781	0.000	0.323	0.779	1.420	27.711	0.258	0.000	
SAMPLE B		1199	1511	1751	2102	2378	2540	2942	3323	3524	
G.DRY/CC.WET MUD		0.638	0.612	0.587	0.583	0.638	0.609	0.636	0.622	0.562	
G.IR/G.DRY MUD		1.26E-09	7.99E-10	1.50E-10	5.61E-10	-BOL -	2.98E-10	6.19E-10	5.65E-11	4.22E-12	
Σ DREDGE MATERIAL		4.823	2.478	0.000	1.259	0.000	0.000	1.532	0.000	0.000	
SAMPLE C		1200	1512	1752	2103	2379	2541	2943	3324	3525	
G.DRY/CC.WET MUD		0.694	0.675	0.777	0.759	0.632	0.723	0.730	0.801	0.654	
G.IR/G.DRY MUD		1.25E-09	2.19E-09	1.19E-10	4.68E-10	4.72E-11	1.49E-10	1.28E-09	1.47E-10	0.00E+00	
Σ DREDGE MATERIAL		4.777	9.618	0.000	0.779	0.000	0.000	4.952	0.000	0.000	
SAMPLE D		4500	4502			4770					
G.DRY/CC.WET MUD		0.843	0.847			0.765					
G.IR/G.DRY MUD		2.91E-11	7.07E-11			2.89E-11					
Σ DREDGE MATERIAL		0.000	0.000			0.000					
SAMPLE E		4501	4503			4771					
G.DRY/CC.WET MUD		0.792	0.588			0.773					
G.IR/G.DRY MUD		1.52E-09	2.07E-10			-BOL -					
Σ DREDGE MATERIAL		6.165	0.000			0.000					
SAMPLE F											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE G											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE H											
G.DRY/CC.WET MUD											
G.IR/G.DRY MUD											
Σ DREDGE MATERIAL											

COORDINATES		HOLE		LOCATION									
J	C	B	NO.	SAN PABLO BAY FLATS (STAKED)									
SAMPLING DATES			25APR74	22MAY74	13JUN74	22JUL74	14AUG74	9SEP74	4OCT74	23NOV74	9DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)			5.0	5.0	4.5	5.0	5.5	5.0	5.0	5.5	5.0		
THICKNESS OF LAYERS (IN)													
FLUFF			1.5	2.0	2.5	0.0	0.0	1.0	0.0	2.0	0.0		
ACTIVE			8.0	7.0	11.5	4.0	12.0	8.0	8.0	16.0	2.0		
INACTIVE			6.0	6.0	10.0	13.0	4.0	8.0	9.0	4.0	20.0		
SAMPLE A			1231	1540	1744	1993	2341	2620	2797	3265	3463		
G. DRY/CC.WET MUD			0.562	0.580	0.690	0.609	0.577	0.750	0.626	0.518	0.644		
G. IR/G.DRY MUD			1.61E-09	5.02E-08	2.83E-10	-BDL-	5.51E-11	4.92E-10	2.83E-10	-BDL-	4.91E-10		
* DREDGE MATERIAL			6.642	255.769	0.000	0.000	0.000	0.901	0.000	0.000	0.896		
SAMPLE B			1232	1541	1745	1994	2342	2621	2798	3266	3464		
G. DRY/CC.WET MUD			0.678	0.582	0.613	0.754	0.615	0.708	0.668	0.666	0.666		
G. IR/G.DRY MUD			1.35E-09	7.57E-10	1.88E-10	4.23E-10	2.83E-10	8.94E-12	1.15E-10	4.15E-10	1.61E-10		
* DREDGE MATERIAL			5.285	2.263	0.000	0.550	0.000	0.000	0.000	0.510	0.000		
SAMPLE C			1233	1542	1746	1995	2343	2622	2799	3267	3465		
G. DRY/CC.WET MUD			0.736	0.743	0.694	0.630	0.769	0.758	0.718	0.825	0.690		
G. IR/G.DRY MUD			1.03E-09	5.54E-10	2.16E-10	2.57E-10	1.25E-10	2.68E-10	3.53E-11	1.90E-11	7.64E-10		
* DREDGE MATERIAL			3.681	1.221	0.000	0.000	0.000	0.000	0.000	0.000	2.298		
SAMPLE D			4504	4506							4768		
G. DRY/CC.WET MUD			0.689	0.923							0.808		
G. IR/G.DRY MUD			1.45E-10	1.81E-10							3.38E-10		
* DREDGE MATERIAL			0.000	0.000							0.111		
SAMPLE E			4505	4507									
G. DRY/CC.WET MUD			0.649	0.862									
G. IR/G.DRY MUD			2.17E-10	3.12E-10									
* DREDGE MATERIAL			0.000	0.000									
SAMPLE F											4769		
G. DRY/CC.WET MUD											0.835		
G. IR/G.DRY MUD											4.98E-11		
* DREDGE MATERIAL											0.000		
SAMPLE G													
G. DRY/CC.WET MUD													
G. IR/G.DRY MUD													
* DREDGE MATERIAL													
SAMPLE H													
G. DRY/CC.WET MUD													
G. IR/G.DRY MUD													
* DREDGE MATERIAL													



COORDINATES		HOLE NO.	LOCATION								
K	E	2	5	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES				18APR74	21MAY74	18JUN74	14AUG74	12SEP74	30CT74	12NOV74	9DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)				3.0	2.0	3.5	4.0	4.0	3.0	3.0	3.0
THICKNESS OF LAYERS (IN)											
FLUFF				1.5	1.0	1.0	0.0	0.0	1.0	0.0	1.0
ACTIVE				7.0	6.0	5.0	1.0	6.0	6.0	8.0	6.0
INACTIVE				11.0	6.0	10.0	12.0	11.0	10.0	17.0	15.0
SAMPLE A				1183	1522	1828	1960	2386	2596	2785	3196
G. DRY/CC. WET MUD				0.624	0.571	0.873	0.838	0.703	0.755	0.724	0.491
G. IR/G. DRY MUD				2.82E-10	1.30E-09	4.21E-10	2.32E-09	1.83E-10	5.55E-10	4.42E-10	9.55E-11
Σ DREDGE MATERIAL				0.000	5.031	0.541	10.297	0.000	1.223	1.354	0.646
SAMPLE B				1184	1523	1829	1961	2387	2597	2786	3197
G. DRY/CC. WET MUD				0.727	0.762	0.748	0.794	0.766	0.764	0.692	0.730
G. IR/G. DRY MUD				4.82E-10	3.84E-10	-BOL-	1.69E-09	5.44E-10	8.37E-10	4.63E-11	1.18E-10
Σ DREDGE MATERIAL				0.850	0.350	0.000	7.071	1.167	2.670	0.000	0.754
SAMPLE C				1185	1524	1830	1962	2388	2598	2787	3198
G. DRY/CC. WET MUD				0.760	0.606	0.733	0.891	0.743	0.805	0.852	0.792
G. IR/G. DRY MUD				4.36E-10	4.28E-10	4.24E-12	5.28E-10	4.15E-11	1.44E-10	8.40E-11	1.32E-10
Σ DREDGE MATERIAL				0.616	0.576	0.000	1.088	0.000	0.000	0.000	0.000
SAMPLE D							4510				
G. DRY/CC. WET MUD							0.807				
G. IR/G. DRY MUD							1.34E-10				
Σ DREDGE MATERIAL							0.000				
SAMPLE E											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE F											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE G											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											
SAMPLE H											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
Σ DREDGE MATERIAL											

COORDINATES		HOLE NO.		LOCATION					
J	E	2	5	89	SAN PABLO BAY FLATS (STAKED)				
SAMPLING DATES		18APR74	21MAY74	18JUN74	14AUG74	12SEP74	30OCT74	12NOV74	30DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.5	5.0	5.0	5.5	5.5	5.5	5.0	5.0
THICKNESS OF LAYERS (IN)									
FLUFF		0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0
ACTIVE		9.0	7.0	7.0	1.0	9.0	8.0	8.0	7.0
INACTIVE		10.0	7.0	12.0	5.0	12.0	12.0	12.0	12.0
SAMPLE A		1186	1480	1840	1951	2344	2599	2788	3205
G. DRY/CC. WET MUD		0.626	0.595	0.851	0.715	0.855	0.790	0.741	0.619
G. IR/G. DRY MUD		5.83E-10	4.06E-10	2.37E-10	9.41E-10	-BDL	2.54E-10	6.97E-11	1.4E-09
Σ DREDGE MATERIAL		1.882	0.463	0.000	3.206	0.000	0.000	0.000	4.246
SAMPLE B		1187	1481	1841	1952	2345	2600	2789	3206
G. DRY/CC. WET MUD		0.635	0.641	0.722	0.740	0.851	0.663	0.593	0.637
G. IR/G. DRY MUD		7.21E-10	2.60E-10	5.69E-10	8.84E-10	1.92E-10	2.04E-10	1.91E-11	7.4E-10
Σ DREDGE MATERIAL		2.07E	0.000	1.298	2.912	0.000	0.000	0.000	0.811
SAMPLE C		1188	1482	1842	1953	2346	2601	2790	3207
G. DRY/CC. WET MUD		0.651	0.594	0.604	0.604	0.687	0.703	0.686	0.682
G. IR/G. DRY MUD		3.75E-10	6.59E-10	1.07E-10	7.07E-10	1.47E-10	5.55E-10	-BDL	5.25E-10
Σ DREDGE MATERIAL		0.303	1.759	0.000	2.006	0.000	1.223	0.000	1.074
SAMPLE D			4513	4543	4545	4546	4546	4766	4764
G. DRY/CC. WET MUD			0.576	0.584	0.554	0.617	0.617	0.624	0.717
G. IR/G. DRY MUD			2.95E-10	-BDL	7.69E-11	-BDL	-BDL	1.21E-10	1.39E-10
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE E			4544	4544	4544	4544	4544	4766	4764
G. DRY/CC. WET MUD			0.711	0.711	0.711	0.711	0.711	0.624	0.717
G. IR/G. DRY MUD			1.22E-10	1.22E-10	1.22E-10	1.22E-10	1.22E-10	1.21E-10	1.39E-10
Σ DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE F									
G. DRY/CC. WET MUD									
G. IR/G. DRY MUD									
Σ DREDGE MATERIAL									
SAMPLE G									
G. DRY/CC. WET MUD									
G. IR/G. DRY MUD									
Σ DREDGE MATERIAL									
SAMPLE H									
G. DRY/CC. WET MUD									
G. IR/G. DRY MUD									
Σ DREDGE MATERIAL									

COORDINATES			HOLE NO.	LOCATION											
1	2	5	90	SAN PABLO BAY FLATS (STAKED)											
SAMPLING DATES			18APR74	21MAY74	6JUN74	18JUL74	6AUG74	12SEP74	30CT74	12NOV74	16DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)			5.0	6.0	7.0	7.0	6.5	7.0	7.0	6.5	7.0				
THICKNESS OF LAYERS (IN)															
FLUFF			0.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0				
ACTIVE			10.0	6.0	7.0	1.0	5.0	11.0	3.0	9.0	5.0				
INACTIVE			9.0	7.0	15.0	17.0	9.0	13.0	13.0	21.0	14.0				
SAMPLE A			1207	1555	1636	1957	2254	2602	2791	3169	3628				
G.DRY/CC.WET MUD			0.641	0.761	0.712	0.724	0.513	0.697	0.756	0.706	0.729				
G.IR/G.DRY MUD			1.31E-09	4.87E-10	3.30E-10	4.99E-10	1.33E-10	-BOL-	9.92E-11	9.48E-10	6.83E-11				
Σ DREDGE MATERIAL			5.124	0.875	0.073	0.939	0.000	0.000	0.000	3.239	0.000				
SAMPLE B			1208	1556	1637	1958	2255	2603	2792	3170	3629				
G.DRY/CC.WET MUD			0.650	0.854	0.806	0.721	0.657	0.699	0.664	0.721	0.607				
G.IR/G.DRY MUD			1.96E-09	3.45E-10	2.72E-10	3.80E-10	6.00E-10	4.92E-10	2.10E-10	6.60E-10	2.44E-10				
Σ DREDGE MATERIAL			8.451	0.148	0.000	0.330	2.996	0.905	0.000	1.767	0.000				
SAMPLE C			1209	1557	1638	1959	2256	2604	2793	3171	3630				
G.DRY/CC.WET MUD			0.607	0.646	0.691	0.652	0.647	0.688	0.694	0.635	0.642				
G.IR/G.DRY MUD			4.13E-09	7.29E-10	5.08E-10	5.95E-10	-BOL-	5.55E-10	2.10E-10	1.41E-10	1.37E-10				
Σ DREDGE MATERIAL			19.547	2.119	0.985	1.433	0.000	1.223	0.000	0.000	0.000				
SAMPLE D			4548	4550				4551	4553	4879					
G.DRY/CC.WET MUD			0.611	0.613				0.663	0.599	0.536					
G.IR/G.DRY MUD			-BOL-	2.15E-10				-BOL-	3.67E-10	5.20E-10					
Σ DREDGE MATERIAL			0.000	0.000				0.000	0.259	1.047					
SAMPLE E			4549					4552	4554						
G.DRY/CC.WET MUD			0.625					0.807	0.649						
G.IR/G.DRY MUD			1.81E-10					-BOL-	4.62E-10						
Σ DREDGE MATERIAL			0.000					0.000	0.750						
SAMPLE F										4880					
G.DRY/CC.WET MUD										0.562					
G.IR/G.DRY MUD										1.79E-10					
Σ DREDGE MATERIAL										0.000					
SAMPLE G															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															
SAMPLE H															
G.DRY/CC.WET MUD															
G.IR/G.DRY MUD															
Σ DREDGE MATERIAL															

COORDINATES		HOLE NO.	LOCATION							
1 E 0 5		91	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		18APR74	20MAY74	18JUN74	18JUL74	6AUG74	12SEP74	30CT74	4NOV74	3DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		2.0	2.5	4.0	3.5	3.0	4.0	3.0	3.5	3.5
THICKNESS OF LAYERS (IN)										
FLUFF		0.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0
ACTIVE		9.0	7.0	6.0	1.0	6.0	7.0	6.0	10.0	1.0
INACTIVE		12.0	14.0	6.0	11.0	9.0	11.0	13.0	15.0	17.0
SAMPLE A		1180	1537	1843	1954	2257	2638	2794	3112	3553
G.DRY/CC.WET MUD		0.664	0.752	0.767	0.765	0.334	0.798	0.690	0.671	0.602
G.IR/G.DRY MUD		2.38E-09	4.99E-10	4.73E-10	3.87E-10	3.73E-10	1.04E-10	1.83E-10	1.79E-10	1.59E-10
Σ DREDGE MATERIAL		10.564	0.938	0.804	0.364	0.294	0.000	0.000	0.000	0.000
SAMPLE B		1181	1538	1844	1955	2258	2639	2795	3113	3554
G.DRY/CC.WET MUD		0.712	0.752	0.862	0.558	0.539	0.655	0.689	0.777	0.563
G.IR/G.DRY MUD		5.83E-10	1.48E-09	2.01E-10	6.93E-10	5.93E-10	1.98E-10	1.75E-10	1.88E-10	1.24E-10
Σ DREDGE MATERIAL		1.368	5.996	0.000	1.932	1.420	1.446	0.000	0.000	0.000
SAMPLE C		1182	1539	1845	1956	2259	2640	2796	3114	3555
G.DRY/CC.WET MUD		0.685	0.711	0.820	0.667	LOST	0.776	0.760	0.840	0.665
G.IR/G.DRY MUD		2.75E-10	5.01E-10	1.07E-10	3.71E-10	SAMPLE	3.46E-10	4.11E-10	-BOL -	-BOL -
Σ DREDGE MATERIAL		0.000	0.950	0.000	0.281	0.155	0.155	0.490	0.000	0.000
SAMPLE D		4555	4556	4557	4558	4559	4560	4561	4562	4563
G.DRY/CC.WET MUD		0.747	0.745	0.747	0.745	0.747	0.745	0.747	0.745	0.747
G.IR/G.DRY MUD		4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10
Σ DREDGE MATERIAL		0.714	0.000	0.714	0.000	0.714	0.000	0.714	0.000	0.714
SAMPLE E		4556	4557	4558	4559	4560	4561	4562	4563	4564
G.DRY/CC.WET MUD		0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745
G.IR/G.DRY MUD		4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10
Σ DREDGE MATERIAL		0.714	0.000	0.714	0.000	0.714	0.000	0.714	0.000	0.714
SAMPLE F		4557	4558	4559	4560	4561	4562	4563	4564	4565
G.DRY/CC.WET MUD		0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745
G.IR/G.DRY MUD		4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10
Σ DREDGE MATERIAL		0.714	0.000	0.714	0.000	0.714	0.000	0.714	0.000	0.714
SAMPLE G		4558	4559	4560	4561	4562	4563	4564	4565	4566
G.DRY/CC.WET MUD		0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745
G.IR/G.DRY MUD		4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10
Σ DREDGE MATERIAL		0.714	0.000	0.714	0.000	0.714	0.000	0.714	0.000	0.714
SAMPLE H		4559	4560	4561	4562	4563	4564	4565	4566	4567
G.DRY/CC.WET MUD		0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745
G.IR/G.DRY MUD		4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10	-BOL -	4.55E-10
Σ DREDGE MATERIAL		0.714	0.000	0.714	0.000	0.714	0.000	0.714	0.000	0.714

COORDINATES		HOLE NO.	LOCATION							
H E I S		92	SAN PABLO BAY FLATS							
SAMPLING DATES		18APR74	20MAY74	6JUN74	18JUL74	5AUG74	27SEP74	8OCT74	1NOV74	3DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		9.0	10.0	9.0	9.0	9.0	9.5	9.0	9.0	10.0
THICKNESS OF LAYERS (IN)										
FLUFF		2.0	0.5	2.0	0.0	0.5	0.0	2.0	0.0	0.0
ACTIVE		9.0	7.0	8.0	2.0	9.0	9.0	3.0	10.0	2.0
INACTIVE		14.0	9.0	12.0	18.0	5.0	12.0	5.0	6.0	17.0
SAMPLE A		1168	1513	1648	1915	2242	2719	2959	3085	3478
G.DRY/CC.WET MUD		0.720	0.467	0.565	0.601	0.671	0.719	0.610	0.499	0.527
G.IR/G.DRY MUD		6.39E-10	3.09E-10	5.07E-10	4.84E-10	3.55E-11	9.16E-11	7.16E-10	1.95E-10	2.57E-10
Σ DREDGE MATERIAL		1.657	0.000	1.493	0.864	0.000	0.000	2.050	0.000	0.000
SAMPLE B		1169	1514	1649	1916	2243	2720	2960	3086	3479
G.DRY/CC.WET MUD		0.498	0.564	0.568	0.607	0.647	0.564	0.582	0.675	0.640
G.IR/G.DRY MUD		1.04E-09	2.71E-10	5.55E-10	6.86E-11	4.10E-10	7.32E-10	9.35E-10	2.02E-10	5.52E-10
Σ DREDGE MATERIAL		3.721	0.000	1.228	0.000	0.485	2.136	3.172	0.000	1.213
SAMPLE C		1170	1515	1650	1917	2244	2721	2961	3087	3480
G.DRY/CC.WET MUD		0.557	0.629	0.655	0.630	0.617	0.674	0.552	0.710	0.559
G.IR/G.DRY MUD		1.03E-09	3.76E-10	3.39E-09	5.35E-10	2.77E-10	-80L	6.32E-10	2.08E-10	7.13E-10
Σ DREDGE MATERIAL		3.675	0.307	15.757	1.122	0.000	0.000	1.623	0.000	2.038
SAMPLE D		4561	0501	4563	4565					4847
G.DRY/CC.WET MUD		0.613	0.546	0.587	0.550					0.585
G.IR/G.DRY MUD		4.92E-10	1.10E-09	-80L	2.02E-10					4.34E-10
Σ DREDGE MATERIAL		0.903	4.043	0.000	0.000					0.604
SAMPLE E			0502							4848
G.DRY/CC.WET MUD			0.620							0.540
G.IR/G.DRY MUD			5.67E-10							5.74E-10
Σ DREDGE MATERIAL			1.288							1.325
SAMPLE F				4564	4566					
G.DRY/CC.WET MUD				0.555	0.560					
G.IR/G.DRY MUD				2.06E-10	-80L					
Σ DREDGE MATERIAL				0.000	0.000					
SAMPLE G		4562								
G.DRY/CC.WET MUD		0.605								
G.IR/G.DRY MUD		1.30E-10								
Σ DREDGE MATERIAL		0.000								
SAMPLE H										
G.DRY/CC.WET MUD										
G.IR/G.DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES		HOLE		LOCATION						
NO.		93		SAN PABLO BAY FLATS						
GE 0 5										
SAMPLING DATES		18APR74	20MAY74	20JUN74	18JUL74	6AUG74	27SEP74	8OCT74	1NOV74	3DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		13.0	10.5	11.5	11.5	12.0	12.0	12.0	12.0	12.0
THICKNESS OF LAYERS (IN)										
FLUFF		1.0	1.5	1.0	1.0	1.0	0.0	0.0	0.0	0.0
ACTIVE		11.0	17.0	5.0	5.0	15.0	6.0	6.0	10.0	2.0
INACTIVE		14.0	0.0	8.0	11.0	6.0	10.0	6.0	6.0	19.0
SAMPLE A		1192	1525	1864	1918	2212	2722	2950	3088	3538
G. DRY/CC. WET MUD		0.445	0.544	0.537	0.564	0.523	0.635	0.511	0.505	0.738
G. IR/G. DRY MUD		6.57E-10	7.03E-10	4.34E-10	1.50E-10	-BOL -	2.33E-10	5.83E-09	1.47E-10	-BOL -
Σ DREDGE MATERIAL		1.749	1.985	0.608	0.000	0.000	0.000	28.257	0.000	0.000
SAMPLE B		1193	1526	1865	1919	2213	2723	2951	3089	3539
G. DRY/CC. WET MUD		0.623	0.749	0.721	0.565	0.645	0.556	0.566	0.693	0.640
G. IR/G. DRY MUD		8.01E-10	7.09E-10	2.96E-10	3.64E-10	1.19E-10	4.74E-10	6.45E-10	3.01E-10	3.16E-10
Σ DREDGE MATERIAL		2.490	2.017	0.000	0.246	0.000	0.812	1.686	0.000	0.000
SAMPLE C		1194	1527	1866	1920	2214	2724	2952	3090	3540
G. DRY/CC. WET MUD		0.615	0.681	0.678	0.620	0.637	0.723	0.792	0.789	0.712
G. IR/G. DRY MUD		4.74E-10	4.87E-10	4.36E-10	1.64E-10	-BOL -	1.10E-10	1.77E-09	3.58E-10	8.65E-11
Σ DREDGE MATERIAL		0.811	0.876	0.615	0.000	0.000	0.000	7.468	0.214	0.000
SAMPLE D						4762		4554		
G. DRY/CC. WET MUD						0.810		0.687		
G. IR/G. DRY MUD						-BOL -		-BOL -		
Σ DREDGE MATERIAL						0.000		0.000		
SAMPLE E						4763				
G. DRY/CC. WET MUD						0.676				
G. IR/G. DRY MUD						4.74E-11				
Σ DREDGE MATERIAL						0.000				
SAMPLE F								4555		
G. DRY/CC. WET MUD								0.815		
G. IR/G. DRY MUD								3.45E-11		
Σ DREDGE MATERIAL								0.000		
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES		HOLE NO.	LOCATION									
F	E	1	5	94	SAN PABLO STRAIT							
SAMPLING DATES		24APR74	15MAY74	20JUN74	31JUL74	20AUG74	30SEP74	8OCT74	15NOV74	16DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		43.0	43.5	45.0	44.5	44.0	44.0	44.0	45.0	44.0		
THICKNESS OF LAYERS (IN)												
FLUFF		-NA-	3.0	1.0	0.0	0.0	0.0	0.0	2.0	1.0		
ACTIVE		-NA-	6.0	4.0	4.0	5.0	3.0	6.0	11.0	10.0		
INACTIVE		-NA-	15.0	12.0	12.0	12.0	18.0	11.0	8.0	14.0		
SAMPLE A			1462	1867	2155	2398	2761	2962	3283	3616		
G.DRY/CC.WET MUD		NO	0.686	1.123	0.886	0.831	1.068	0.774	0.774	0.657		
G.IR/G.DRY MUD		SAMPLE	3.71E-10	9.74E-11	2.31E-10	2.66E-10	1.63E-10	1.68E-09	-BOL -	9.69E-11		
DREDGE MATERIAL			0.281	0.000	0.000	0.000	0.000	7.004	0.000	0.000		
SAMPLE B			1463	1868	2156	2399	2762	2963	3284	3617		
G.DRY/CC.WET MUD		NO	0.835	0.791	0.774	0.855	0.878	0.801	0.917	0.585		
G.IR/G.DRY MUD		SAMPLE	3.47E-10	3.46E-10	4.18E-10	2.43E-10	4.65E-10	2.38E-09	8.07E-10	1.56E-10		
DREDGE MATERIAL			0.159	0.154	0.525	0.000	0.762	10.579	2.521	0.000		
SAMPLE C			1464	1869	2157	2400	2763	2964	3285	3618		
G.DRY/CC.WET MUD		NO	0.703	0.792	0.847	0.975	0.764	0.776	0.741	0.672		
G.IR/G.DRY MUD		SAMPLE	2.42E-10	3.05E-10	8.95E-11	5.24E-11	6.24E-11	9.69E-10	-BOL -	-BOL -		
DREDGE MATERIAL			0.000	0.000	0.000	0.000	0.000	3.349	0.000	0.000		
SAMPLE D						4791						
G.DRY/CC.WET MUD						0.832						
G.IR/G.DRY MUD						2.09E-10						
DREDGE MATERIAL						0.000						
SAMPLE E						4792						
G.DRY/CC.WET MUD						0.920						
G.IR/G.DRY MUD						6.05E-11						
DREDGE MATERIAL						0.000						
SAMPLE F												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
DREDGE MATERIAL												
SAMPLE G												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
DREDGE MATERIAL												
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
DREDGE MATERIAL												



COORDINATES			HOLE NO.	LOCATION									
G E 2 5			96	SAN PABLO STRAIT									
SAMPLING DATES			19APR74	20MAY74	20JUN74	24JUL74	20AUG74	28SEP74	8OCT74	4NOV74	3DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)			27.0	19.0	25.0	23.5	25.0	25.0	25.0	25.0	25.0		
THICKNESS OF LAYERS (IN)													
FLUFF			5.5	1.5	2.0	1.0	1.0	1.0	2.0	0.0	0.0		
ACTIVE			8.0	8.0	7.0	7.0	13.0	7.0	6.0	11.0	4.0		
INACTIVE			8.0	6.0	12.0	10.0	3.0	6.0	9.0	16.0	25.0		
SAMPLE A			1279	1528	1858	2056	2425	2734	2968	3115	3499		
G.DRY/CC.WET MUD			0.605	0.565	0.652	0.642	0.734	0.768	0.561	0.442	0.581		
G.IR/G.DRY MUD			4.16E-10	2.02E-10	4.03E-10	1.55E-10	1.32E-09	2.38E-10	5.05E-09	3.11E-10	3.65E-10		
Σ DREDGE MATERIAL			0.513	0.000	0.447	0.000	5.142	0.000	24.264	0.000	0.250		
SAMPLE B			1280	1529	1859	2057	2426	2735	2969	3116	3500		
G.DRY/CC.WET MUD			0.549	0.399	0.508	0.594	0.567	0.459	0.511	0.482	0.475		
G.IR/G.DRY MUD			3.07E-10	5.27E-10	4.62E-10	3.01E-10	7.74E-11	3.47E-10	6.39E-10	-BOL-	1.49E-10		
Σ DREDGE MATERIAL			0.000	1.083	0.748	0.000	0.000	0.158	1.657	0.000	0.000		
SAMPLE C			1281	1530	1860	2058	2427	2736	2970	3117	3501		
G.DRY/CC.WET MUD			0.524	0.493	0.472	0.576	0.578	0.638	0.626	0.452	0.547		
G.IR/G.DRY MUD			1.84E-10	5.15E-10	4.73E-10	3.84E-10	1.73E-10	-BOL-	1.11E-09	3.99E-10	3.91E-10		
Σ DREDGE MATERIAL			0.000	1.021	0.808	0.349	0.000	0.000	4.071	0.424	0.384		
SAMPLE D			4658										
G.DRY/CC.WET MUD			0.780										
G.IR/G.DRY MUD			5.84E-10										
Σ DREDGE MATERIAL			1.373										
SAMPLE E			4659										
G.DRY/CC.WET MUD			0.663										
G.IR/G.DRY MUD			2.10E-10										
Σ DREDGE MATERIAL			0.000										
SAMPLE F			4659										
G.DRY/CC.WET MUD			0.780										
G.IR/G.DRY MUD			5.84E-10										
Σ DREDGE MATERIAL			1.373										
SAMPLE G			4659										
G.DRY/CC.WET MUD			0.663										
G.IR/G.DRY MUD			2.10E-10										
Σ DREDGE MATERIAL			0.000										
SAMPLE H			4659										
G.DRY/CC.WET MUD			0.780										
G.IR/G.DRY MUD			5.84E-10										
Σ DREDGE MATERIAL			1.373										

COORDINATES		HOLE NO.	LOCATION									
G H	2 5	97	SAN PABLO STRAIT									
SAMPLING DATES		19APR74	20MAY74	20JUN74	24JUL74	20AUG74	28SEP74	8OCT74	4NOV74	30DEC74		
DEPTH OF SEDIMENT BELOW MLLW (FT)		14.5	14.0	13.5	13.5	14.0	14.0	14.0	15.0	14.5		
THICKNESS OF FLUFF LAYERS (IN)		0.5	3.0	1.0	1.5	0.0	1.0	1.0	0.0	0.0		
ACTIVE		7.0	9.0	5.0	8.0	8.0	12.0	7.0	9.0	3.0		
INACTIVE		20.0	9.0	13.0	3.0	9.0	7.0	10.0	10.0	20.0		
SAMPLE A		1261	1531	1855	2080	2401	2737	2971	3118	3520		
G.DRY/CC.WET MUD		0.541	0.582	0.379	0.518	0.657	0.531	0.564	0.442	0.556		
G.1R/G.DRY MUD		4.78E-10	1.17E-09	3.87E-10	1.13E-09	2.87E-10	-80L	4.15E-10	-80L	9.65E-11		
Σ DREDGE MATERIAL		0.832	4.376	0.363	4.170	0.000	0.000	0.510	0.000	0.000		
SAMPLE B		1262	1532	1856	2081	2402	2738	2972	3119	3521		
G.DRY/CC.WET MUD		0.605	0.485	0.569	0.583	0.538	0.515	0.515	0.638	0.450		
G.1R/G.DRY MUD		4.39E-10	4.33E-09	1.65E-10	6.81E-10	4.22E-10	1.54E-10	5.13E-09	4.15E-10	2.72E-10		
Σ DREDGE MATERIAL		0.629	20.566	0.000	1.871	0.544	0.000	24.696	0.510	0.000		
SAMPLE C		1263	1533	1857	2082	2403	2739	2973	3120	3522		
G.DRY/CC.WET MUD		0.584	0.489	0.578	0.900	0.615	0.586	0.622	0.558	0.555		
G.1R/G.DRY MUD		4.67E-10	2.18E-10	2.19E-10	7.91E-10	3.81E-10	-80L	4.06E-10	3.30E-10	2.94E-10		
Σ DREDGE MATERIAL		0.777	0.000	0.000	2.435	0.334	0.000	0.464	0.071	0.000		
SAMPLE D		1264	1534	1858	2083	2404	2740	2974	3121	3523		
G.DRY/CC.WET MUD		0.584	0.489	0.578	0.900	0.615	0.586	0.622	0.558	0.555		
G.1R/G.DRY MUD		4.67E-10	2.18E-10	2.19E-10	7.91E-10	3.81E-10	-80L	4.06E-10	3.30E-10	2.94E-10		
Σ DREDGE MATERIAL		0.777	0.000	0.000	2.435	0.334	0.000	0.464	0.071	0.000		
SAMPLE E		1265	1535	1859	2084	2405	2741	2975	3122	3524		
G.DRY/CC.WET MUD		0.584	0.489	0.578	0.900	0.615	0.586	0.622	0.558	0.555		
G.1R/G.DRY MUD		4.67E-10	2.18E-10	2.19E-10	7.91E-10	3.81E-10	-80L	4.06E-10	3.30E-10	2.94E-10		
Σ DREDGE MATERIAL		0.777	0.000	0.000	2.435	0.334	0.000	0.464	0.071	0.000		
SAMPLE F		1266	1536	1860	2085	2406	2742	2976	3123	3525		
G.DRY/CC.WET MUD		0.584	0.489	0.578	0.900	0.615	0.586	0.622	0.558	0.555		
G.1R/G.DRY MUD		4.67E-10	2.18E-10	2.19E-10	7.91E-10	3.81E-10	-80L	4.06E-10	3.30E-10	2.94E-10		
Σ DREDGE MATERIAL		0.777	0.000	0.000	2.435	0.334	0.000	0.464	0.071	0.000		
SAMPLE G		1267	1537	1861	2086	2407	2743	2977	3124	3526		
G.DRY/CC.WET MUD		0.584	0.489	0.578	0.900	0.615	0.586	0.622	0.558	0.555		
G.1R/G.DRY MUD		4.67E-10	2.18E-10	2.19E-10	7.91E-10	3.81E-10	-80L	4.06E-10	3.30E-10	2.94E-10		
Σ DREDGE MATERIAL		0.777	0.000	0.000	2.435	0.334	0.000	0.464	0.071	0.000		
SAMPLE H		1268	1538	1862	2087	2408	2744	2978	3125	3527		
G.DRY/CC.WET MUD		0.584	0.489	0.578	0.900	0.615	0.586	0.622	0.558	0.555		
G.1R/G.DRY MUD		4.67E-10	2.18E-10	2.19E-10	7.91E-10	3.81E-10	-80L	4.06E-10	3.30E-10	2.94E-10		
Σ DREDGE MATERIAL		0.777	0.000	0.000	2.435	0.334	0.000	0.464	0.071	0.000		

COORDINATES	HOLE NO.	LOCATION										
H C 2 B	98	SAN PABLO BAY FLATS (STAKED)										
SAMPLING DATES	26APR74	21MAY74	6JUN74	24JUL74	1AUG74	28SEP74	15OCT74	4NOV74	16DEC74			
DEPTH OF SEDIMENT BELOW MLLW (FT)	11.0	11.5	11.5	11.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
THICKNESS OF LAYERS (IN)												
FLUFF	1.5	1.0	1.0	0.0	1.0	2.0	1.0	0.0	1.0	0.0	1.0	1.0
ACTIVE	8.0	8.0	10.5	4.0	7.0	3.0	6.0	13.0	11.0	13.0	11.0	11.0
INACTIVE	12.0	9.0	9.0	14.0	11.0	8.0	11.0	16.0	11.0	16.0	14.0	14.0
SAMPLE A	1282	1501	1654	2041	2200	2740	2995	3097	3622	3097	3622	3622
G. DRY/CC.WET MUD	0.571	0.546	0.590	0.608	0.516	0.574	0.428	0.491	0.533	0.428	0.491	0.533
G. IR/G.DRY MUD	4.11E-10	7.18E-10	1.78E-10	6.16E-10	6.16E-10	7.29E-11	4.65E-10	3.00E-10	8.16E-11	3.00E-10	8.16E-11	8.16E-11
Σ DREDGE MATERIAL	0.487	2.314	2.060	0.000	1.541	0.000	0.762	0.000	0.000	0.762	0.000	0.000
SAMPLE B	1283	1502	1655	2042	2201	2741	2996	3098	3623	3098	3623	3623
G. DRY/CC.WET MUD	0.565	0.593	0.560	0.579	0.580	0.533	0.456	0.483	0.516	0.456	0.483	0.516
G. IR/G.DRY MUD	1.74E-10	1.63E-09	1.79E-10	1.02E-10	1.98E-10	8.01E-11	3.36E-10	8.63E-11	3.38E-10	3.36E-10	8.63E-11	3.38E-10
Σ DREDGE MATERIAL	0.000	6.742	0.000	0.000	0.000	0.000	0.102	0.000	0.112	0.102	0.000	0.112
SAMPLE C	1284	1503	1656	2043	2202	2742	2997	3099	3624	3099	3624	3624
G. DRY/CC.WET MUD	0.545	0.566	0.553	0.618	0.598	0.568	0.584	0.700	0.632	0.584	0.700	0.632
G. IR/G.DRY MUD	3.93E-10	1.90E-09	6.47E-10	5.12E-10	4.40E-10	2.46E-10	1.70E-09	3.97E-10	4.35E-11	1.70E-09	3.97E-10	4.35E-11
Σ DREDGE MATERIAL	0.396	8.119	1.696	1.007	0.635	0.000	7.109	0.414	0.000	7.109	0.414	0.000
SAMPLE D		4574	4576				4578			4578		
G. DRY/CC.WET MUD		0.587	0.594				0.616			0.616		
G. IR/G.DRY MUD		2.17E-10	1.11E-10				5.99E-10			5.99E-10		
Σ DREDGE MATERIAL		0.000	0.000				1.452			1.452		
SAMPLE E		4575										
G. DRY/CC.WET MUD		0.603										
G. IR/G.DRY MUD		2.30E-10										
Σ DREDGE MATERIAL		0.000										
SAMPLE F		4577										
G. DRY/CC.WET MUD		0.591										
G. IR/G.DRY MUD		2.97E-11										
Σ DREDGE MATERIAL		0.000										
SAMPLE G												
G. DRY/CC.WET MUD												
G. IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G. DRY/CC.WET MUD												
G. IR/G.DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE LOCATION		NO. 99 SAN PABLO BAY FLATS (STAKED)									
H	E	2	5	26APR74	21MAY74	6JUN74	24JUL74	1AUG74	28SEP74	16OCT74	4NOV74	16DEC74	
SAMPLING DATES				8.0	9.0	9.0	9.0	9.5	9.0	9.5	9.0	9.5	
DEPTH OF SEDIMENT BELOW MLW (FT)													
THICKNESS OF LAYERS (IN)													
FLUFF				1.0	1.0	1.0	0.0	0.5	1.0	2.0	0.0	1.0	
ACTIVE				7.0	4.0	10.5	6.0	5.0	6.0	4.0	13.0	2.0	
INACTIVE				9.0	10.0	3.0	10.0	6.0	10.0	11.0	8.0	24.0	
SAMPLE A				1285	1546	1651	2044	2290	2743	2998	3121	3633	
G.DRY/CC.WET MUD				0.606	0.581	0.562	0.628	0.597	0.737	0.664	0.583	0.733	
G.IR/G.DRY MUD				4.73E-10	5.80E-10	5.25E-10	3.73E-10	3.37E-10	2.21E-10	1.93E-10	2.52E-10	2.71E-10	
Σ DREDGE MATERIAL				0.808	1.355	1.073	0.294	0.109	0.000	0.000	0.000	0.000	
SAMPLE B				1286	1547	1652	2045	2291	2744	2999	3122	3632	
G.DRY/CC.WET MUD				0.559	0.708	0.564	0.495	0.678	0.503	0.564	0.562	0.654	
G.IR/G.DRY MUD				8.67E-10	2.54E-10	4.71E-10	7.15E-10	1.93E-10	3.00E-10	1.57E-10	2.01E-10	8.14E-11	
Σ DREDGE MATERIAL				2.826	0.000	0.796	2.045	0.000	0.000	0.000	0.000	0.000	
SAMPLE C				1287	1548	1653	2046	2292	2745	3000	3123	3633	
G.DRY/CC.WET MUD				0.542	0.613	0.531	0.444	0.631	0.599	0.715	0.710	0.614	
G.IR/G.DRY MUD				4.40E-10	5.22E-10	1.72E-10	1.55E-10	-BDL-	-BDL-	8.10E-10	1.58E-10	2.35E-10	
Σ DREDGE MATERIAL				0.638	1.056	0.000	0.000	0.000	0.000	2.533	0.000	0.000	
SAMPLE D				4580						4582			
G.DRY/CC.WET MUD				0.627						0.660			
G.IR/G.DRY MUD				1.27E-10						3.87E-10			
Σ DREDGE MATERIAL				0.000						0.363			
SAMPLE E				4581						4583			
G.DRY/CC.WET MUD				0.589						0.622			
G.IR/G.DRY MUD				4.08E-10						-BDL-			
Σ DREDGE MATERIAL				0.471						0.000			
SAMPLE F													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE G													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													
SAMPLE H													
G.DRY/CC.WET MUD													
G.IR/G.DRY MUD													
Σ DREDGE MATERIAL													

COORDINATES	HOLE NO.	LOCATION								
1 E 3 S	100	SAN PABLO BAY FLATS (STAKED)								
SAMPLING DATES	26APR74	21MAY74	7JUN74	22JUL74	6AUG74	5SEP74	30CT74	12NOV74	16DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)	5.5	7.0	6.5	7.0	7.0	7.0	7.0	8.0	8.0	
THICKNESS OF LAYERS (IN)										
FLUFF	1.0	0.5	2.0	0.5	0.0	0.0	0.0	1.0	1.0	
ACTIVE	7.0	8.0	11.0	5.0	6.0	7.0	2.0	7.0	14.0	
INACTIVE	8.0	10.0	-NA-	10.0	10.0	10.0	14.0	14.0	6.0	
SAMPLE A	1288	1486	1669	1990	2206	2542	2839	3172	3604	
G. DRY/CC. WET MUD	0.555	0.777	0.628	0.805	0.697	0.839	0.584	0.606	0.753	
G. IR/G. DRY MUD	3.27E-10	3.71E-10	3.35E-10	5.95E-10	5.73E-11	1.05E-10	2.05E-10	4.18E-10	3.06E-10	
* DREDGE MATERIAL	0.056	0.285	0.099	1.430	0.000	0.000	0.000	0.523	0.000	
SAMPLE B	1289	1487	1670	1991	2207	2543	2840	3173	3605	
G. DRY/CC. WET MUD	0.722	0.697	0.734	0.839	0.577	0.778	0.702	0.772	0.627	
G. IR/G. DRY MUD	3.72E-10	4.37E-10	3.43E-10	6.02E-10	3.18E-10	1.65E-10	3.15E-10	1.77E-10	3.66E-11	
* DREDGE MATERIAL	0.286	0.622	0.136	1.468	0.008	0.000	0.000	0.000	0.000	
SAMPLE C	1290	1488	1671	1992	2208	2544	2841	3174	3606	
G. DRY/CC. WET MUD	0.774	0.606	0.902	0.697	0.509	0.751	0.830	0.752	0.746	
G. IR/G. DRY MUD	3.48E-10	5.15E-10	2.00E-10	2.48E-10	6.19E-10	2.38E-10	4.39E-10	1.48E-10	2.32E-10	
* DREDGE MATERIAL	0.164	1.019	0.000	0.000	1.554	0.000	0.629	0.000	0.000	
SAMPLE D		4584			4586		4860			
G. DRY/CC. WET MUD		0.778			0.782		0.563			
G. IR/G. DRY MUD		1.79E-10			1.35E-10		4.53E-10			
* DREDGE MATERIAL		0.000			0.000		0.705			
SAMPLE E		4585			4587					
G. DRY/CC. WET MUD		0.707			0.843					
G. IR/G. DRY MUD		2.12E-10			8.16E-12					
* DREDGE MATERIAL		0.000			0.000					
SAMPLE F										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
* DREDGE MATERIAL										
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
* DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
* DREDGE MATERIAL										

4861  
0.586  
2.33E-10  
0.000

COORDINATES			HOLE NO.	LOCATION												
J	C	4	3	101	SAN PABLO BAY FLATS (STAKED)											
SAMPLING DATES			25APR74	22MAY74	13JUN74	22JUL74	14AUG74	9SEP74	4OCT74	23NOV74	9DEC74					
DEPTH OF SEDIMENT BELOW MLLW (FT)			5.0	5.0	5.0	5.5	6.0	5.5	5.0	5.5	5.5					
THICKNESS OF LAYERS (IN)																
FLUFF			1.0	3.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0					
ACTIVE			5.0	8.0	6.0	7.0	8.0	10.0	7.0	17.0	2.0					
INACTIVE			9.0	6.0	12.0	9.0	4.0	11.0	8.0	3.0	15.0					
SAMPLE A			1222	1534	1753	1987	2347	2569	2944	3271	3409					
G.DRY/CC.WET MUD			0.520	0.453	0.724	0.750	0.680	0.737	0.655	0.471	0.660					
G.IR/G.DRY MUD			9.03E-10	3.38E-10	3.72E-10	5.78E-10	1.29E-10	1.75E-10	1.97E-09	4.17E-10	3.40E-10					
* DREDGE MATERIAL			3.011	0.113	0.288	1.342	0.000	0.000	8.479	0.518	0.123					
SAMPLE B			1223	1535	1754	1988	2348	2570	2945	3272	3410					
G.DRY/CC.WET MUD			0.657	0.703	0.664	0.661	0.648	0.641	0.665	0.584	0.619					
G.IR/G.DRY MUD			2.80E-09	3.68E-10	4.30E-10	5.33E-10	-BOL	-BOL	2.54E-09	3.01E-10	2.62E-10					
* DREDGE MATERIAL			12.751	0.268	0.585	1.111	0.000	0.000	11.392	0.000	0.000					
SAMPLE C			1224	1536	1755	1989	2349	2571	2946	3273	3411					
G.DRY/CC.WET MUD			0.675	0.767	0.718	0.705	0.676	0.761	0.759	0.799	0.687					
G.IR/G.DRY MUD			3.66E-09	4.78E-10	5.92E-10	3.93E-10	4.76E-10	4.13E-10	7.40E-10	8.23E-11	-BOL					
* DREDGE MATERIAL			17.156	0.830	1.417	0.393	0.921	0.500	2.173	0.000	0.000					
SAMPLE D			4583	4862	4530				4592							
G.DRY/CC.WET MUD			0.668	0.593	0.743				0.695							
G.IR/G.DRY MUD			3.07E-10	2.61E-10	8.92E-10				1.50E-09							
* DREDGE MATERIAL			0.000	0.000	2.953				6.057							
SAMPLE E			4589	4863	4591				4593							
G.DRY/CC.WET MUD			0.694	0.615	0.740				0.776							
G.IR/G.DRY MUD			-BOL	-BOL	2.16E-10				-BOL							
* DREDGE MATERIAL			0.000	0.000	0.000				0.000							
SAMPLE F																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
* DREDGE MATERIAL																
SAMPLE G																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
* DREDGE MATERIAL																
SAMPLE H																
G.DRY/CC.WET MUD																
G.IR/G.DRY MUD																
* DREDGE MATERIAL																

COORDINATES		HOLE NO.	LOCATION							
J H	4 3	102	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		25APR74	22MAY74	13JUN74	22JUL74	14AUG74	9SEP74	4OCT74	23NOV74	9DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.0	4.0	4.5	4.0	5.0	4.5	4.5	4.0	5.0
THICKNESS OF FLUFF LAYERS (IN)		2.0	2.0	2.5	0.0	0.0	1.0	1.0	1.0	0.0
ACTIVE		6.0	8.0	7.0	6.0	6.0	9.0	7.0	15.0	2.0
INACTIVE		4.0	7.0	7.0	8.0	6.0	7.0	8.0	6.0	17.0
SAMPLE A		1243	1549	1747	1963	2410	2623	2803	3274	3469
G.DRY/CC.WET MUD		0.520	0.472	0.675	0.610	0.616	0.695	0.692	0.498	0.557
G.IR/G.DRY MUD		4.85E-09	6.56E-10	3.50E-10	9.27E-10	2.66E-10	4.74E-10	1.13E-10	1.01E-10	2.54E-10
Σ DREDGE MATERIAL		23.272	1.742	0.175	3.136	0.000	0.813	0.000	0.000	0.000
SAMPLE B		1244	1550	1748	1964	2411	2624	2804	3275	3470
G.DRY/CC.WET MUD		0.591	0.577	0.659	0.669	0.631	0.661	0.629	0.676	0.623
G.IR/G.DRY MUD		4.89E-09	7.85E-10	4.06E-10	2.78E-10	1.65E-10	-BOL	2.04E-10	4.87E-10	3.97E-10
Σ DREDGE MATERIAL		23.461	2.405	0.462	0.000	0.000	0.000	0.000	0.875	0.417
SAMPLE C		1245	1551	1749	1965	2412	2625	2805	3276	3471
G.DRY/CC.WET MUD		0.573	0.660	0.682	0.720	0.675	0.703	0.778	0.730	0.632
G.IR/G.DRY MUD		5.78E-09	4.82E-10	2.20E-10	7.65E-10	4.29E-11	1.41E-10	3.35E-10	2.92E-10	3.69E-10
Σ DREDGE MATERIAL		28.017	0.850	0.000	2.304	0.000	0.000	0.099	0.000	0.273
SAMPLE D		4594	4594	4595	4595	4597	4597	4597	4597	4597
G.DRY/CC.WET MUD		0.832	0.729	0.706	0.729	0.706	0.729	0.706	0.729	0.706
G.IR/G.DRY MUD		3.26E-10	0.00E+00	4.70E-10	0.00E+00	4.70E-10	0.00E+00	4.70E-10	0.00E+00	4.70E-10
Σ DREDGE MATERIAL		0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE E		4596	4596	4596	4596	4596	4596	4596	4596	4596
G.DRY/CC.WET MUD		0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661
G.IR/G.DRY MUD		-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE F		4596	4596	4596	4596	4596	4596	4596	4596	4596
G.DRY/CC.WET MUD		0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661
G.IR/G.DRY MUD		-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE G		4596	4596	4596	4596	4596	4596	4596	4596	4596
G.DRY/CC.WET MUD		0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661
G.IR/G.DRY MUD		-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SAMPLE H		4596	4596	4596	4596	4596	4596	4596	4596	4596
G.DRY/CC.WET MUD		0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661
G.IR/G.DRY MUD		-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL	-BOL
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

COORDINATES		HOLE		LOCATION						
J	H	4	B	103	SAN PABLO BAY FLATS (STAKED)					
SAMPLING DATES		25APR74	22MAY74	13JUN74	22JUL74	14AUG74	9SEP74	4OCT74	23NOV74	9DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.0	4.0	4.0	4.0	4.5	4.0	4.0	4.5	5.0
THICKNESS OF LAYERS (IN)		2.0	1.5	3.0	1.0	1.0	1.0	1.0	0.0	0.0
FLUFF		5.0	9.0	7.0	8.0	7.0	9.0	8.0	6.0	3.0
INACTIVE		6.0	7.0	5.0	5.0	4.0	10.0	10.0	17.0	18.0
SAMPLE A		1237	1483	1735	1996	2389	2626	2806	3277	3415
G.DRY/CC.WET MUD		0.503	0.608	0.643	0.722	0.662	0.590	0.677	0.597	0.637
G.1R/G.DRY MUD		8.88E-10	5.82E-10	1.54E-10	4.01E-10	9.89E-10	1.28E-10	2.06E-10	1.07E-09	1.07E-09
* DREDGE MATERIAL		2.934	1.364	0.000	0.435	0.451	3.449	0.000	0.000	3.883
SAMPLE B		1238	1484	1736	1997	2390	2627	2807	3278	3416
G.DRY/CC.WET MUD		0.648	0.668	0.544	0.625	0.632	0.695	0.597	0.704	0.511
G.1R/G.DRY MUD		1.25E-09	3.75E-10	2.49E-10	8.61E-10	5.06E-10	4.21E-12	2.92E-10	1.74E-10	4.20E-10
* DREDGE MATERIAL		4.809	0.305	0.000	2.795	0.973	0.000	0.000	0.000	0.533
SAMPLE C		1239	1485	1737	1998	2391	2628	2808	3279	3417
G.DRY/CC.WET MUD		0.678	0.626	0.650	0.650	0.783	0.768	0.770	0.816	0.613
G.1R/G.DRY MUD		2.95E-09	2.63E-10	1.07E-10	1.07E-10	2.39E-10	1.51E-10	0.00E+00	4.90E-10	7.30E-10
* DREDGE MATERIAL		13.527	0.000	0.000	0.000	0.000	0.000	0.000	0.894	2.125
SAMPLE D		4598	4600							4793
G.DRY/CC.WET MUD		0.736	0.680							0.761
G.1R/G.DRY MUD		5.46E-10	0.00E+00							2.88E-10
* DREDGE MATERIAL		1.182	0.000							0.000
SAMPLE E		4599	4601							4794
G.DRY/CC.WET MUD		0.675	0.776							0.826
G.1R/G.DRY MUD		1.48E-10	-BDL-							2.46E-10
* DREDGE MATERIAL		0.000	0.000							0.000
SAMPLE F										
G.DRY/CC.WET MUD										
G.1R/G.DRY MUD										
* DREDGE MATERIAL										
SAMPLE G										
G.DRY/CC.WET MUD										
G.1R/G.DRY MUD										
* DREDGE MATERIAL										
SAMPLE H										
G.DRY/CC.WET MUD										
G.1R/G.DRY MUD										
* DREDGE MATERIAL										

COORDINATES		HOLE NO.	LOCATION							
J E	4 5	104	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		25APR74	22MAY74	13JUN74	22JUL74	14AUG74	9SEP74	4OCT74	23NOV74	9DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		5.0	5.0	4.5	4.5	5.0	5.0	4.0	5.0	4.5
THICKNESS OF LAYERS (IN)										
FLUFF		1.5	3.0	2.0	0.0	0.0	1.0	1.0	1.0	0.0
ACTIVE		5.0	8.0	7.0	8.0	6.0	6.0	9.0	19.0	2.0
INACTIVE		7.0	9.0	9.0	11.0	6.0	6.0	7.0	5.0	18.0
SAMPLE A		1225	1519	1738	2008	2392	2656	2842	3343	3439
G. DRY/CC. WET MUD		0.483	0.723	0.620	0.610	0.739	0.680	0.575	0.450	0.510
G. IR/G. DRY MUD		1.62E-09	2.78E-10	2.19E-10	5.00E-10	5.58E-11	1.14E-10	3.53E-10	-BDL-	1.54E-09
Σ DREDGE MATERIAL		6.691	0.000	0.000	0.946	0.000	0.000	0.189	0.000	6.263
SAMPLE B		1226	1520	1739	2009	2393	2657	2843	3344	3440
G. DRY/CC. WET MUD		0.672	0.655	0.631	0.670	0.653	0.736	0.619	0.720	0.690
G. IR/G. DRY MUD		1.45E-09	3.52E-10	2.34E-10	3.79E-10	3.53E-10	3.05E-10	3.10E-10	-BDL-	1.44E-09
Σ DREDGE MATERIAL		5.825	0.186	0.000	0.322	0.188	0.000	0.000	0.000	5.747
SAMPLE C		1227	1521	1740	2010	2394	2658	2844	3345	3441
G. DRY/CC. WET MUD		0.655	0.669	0.767	0.710	0.749	0.641	0.709	0.751	0.562
G. IR/G. DRY MUD		2.18E-09	2.97E-10	3.56E-10	5.43E-10	2.35E-10	1.26E-10	0.00E+00	4.35E-10	3.52E-10
Σ DREDGE MATERIAL		9.437	0.000	0.207	1.166	0.000	0.000	0.000	0.612	0.187
SAMPLE D		4602			4604					
G. DRY/CC. WET MUD		0.700			0.637					
G. IR/G. DRY MUD		2.50E-11			-BDL-					
Σ DREDGE MATERIAL		0.000			0.000					
SAMPLE E		4603			4605					
G. DRY/CC. WET MUD		0.706			0.520					
G. IR/G. DRY MUD		-BDL-			2.20E-10					
Σ DREDGE MATERIAL		0.000			0.000					
SAMPLE F										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE G										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										
SAMPLE H										
G. DRY/CC. WET MUD										
G. IR/G. DRY MUD										
Σ DREDGE MATERIAL										

COORDINATES		HOLE NO.	LOCATION											
F	E	3	5	105	SAN PABLO STRAIT									
SAMPLING DATES		19APR74	13MAY74	20JUN74	24JUL74	1AUG74	12SEP74	30CT74	15NOV74	30DEC74				
DEPTH OF SEDIMENT BELOW MLLW (FT)		18.0	17.0	20.0	17.5	18.5	20.0	19.0	20.0	19.5				
THICKNESS OF LAYERS (IN)														
		1.0	1.0	0.0	0.0	0.0	1.0	4.0	2.0	0.0				
FLUFF		10.0	11.0	3.0	10.0	14.0	8.0	6.0	7.0	2.0				
INACTIVE		12.0	10.0	15.0	4.0	2.0	12.0	12.0	17.0	19.0				
SAMPLE A														
		1258	1471	1861	2059	2194	2641	2869	3286	3511				
G. DRY/CC. WET MUD		0.451	0.660	0.796	0.740	0.924	0.597	0.844	0.485	0.637				
G. IR/G. DRY MUD		1.81E-09	1.35E-09	2.92E-10	-BDL	9.17E-12	3.42E-10	1.31E-10	4.72E-10	5.78E-10				
* DREDGE MATERIAL		7.646	5.285	0.000	0.000	0.000	0.135	0.000	0.801	1.345				
SAMPLE B														
		1259	1472	1862	2060	2195	2642	2870	3287	3512				
G. DRY/CC. WET MUD		0.509	0.584	0.486	0.561	0.569	0.544	0.684	0.542	0.506				
G. IR/G. DRY MUD		6.32E-10	4.37E-10	3.26E-10	3.34E-10	6.39E-11	3.93E-11	1.67E-10	-BDL	2.23E-10				
* DREDGE MATERIAL		1.622	0.620	0.051	0.092	0.000	0.000	0.000	0.000	0.000				
SAMPLE C														
		1260	1473	1863	2061	2196	2643	2871	3288	3513				
G. DRY/CC. WET MUD		0.499	0.460	0.528	0.554	0.493	0.538	0.764	0.580	0.555				
G. IR/G. DRY MUD		7.03E-10	1.21E-09	4.30E-10	4.55E-10	3.76E-10	6.74E-11	1.62E-10	4.85E-10	4.48E-12				
* DREDGE MATERIAL		1.987	4.590	0.586	0.712	0.306	0.000	0.000	0.867	0.000				
SAMPLE D														
		4606	4610		4608				4864					
G. DRY/CC. WET MUD		0.475	0.483		0.530				0.489					
G. IR/G. DRY MUD		4.84E-10	2.87E-10		3.53E-10				1.47E-10					
* DREDGE MATERIAL		0.861	0.000		0.189				0.000					
SAMPLE E														
				4609										
G. DRY/CC. WET MUD				0.570										
G. IR/G. DRY MUD				3.17E-10										
* DREDGE MATERIAL				0.008										
SAMPLE F														
			4611											
G. DRY/CC. WET MUD			0.519											
G. IR/G. DRY MUD			4.78E-10											
* DREDGE MATERIAL			0.830											
SAMPLE G														
		4607												
G. DRY/CC. WET MUD		0.660												
G. IR/G. DRY MUD		5.73E-11												
* DREDGE MATERIAL		0.000												
SAMPLE H														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
* DREDGE MATERIAL														

COORDINATES		HOLE LOCATION									
H	E	5	106	SAN PABLO BAY FLATS (STAKED)							
SAMPLING DATES		26APR74	10MAY74	7JUN74	10JUL74	1AUG74	4SEP74	15OCT74	23NOV74	17DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		7.0	7.5	8.0	7.5	9.5	8.5	9.5	9.5	9.5	
THICKNESS OF LAYERS (IN)											
FLUFF		0.0	0.5	1.0	2.0	0.0	1.0	1.0	0.0	1.0	
ACTIVE		10.0	7.0	13.0	7.0	8.0	5.0	4.0	2.0	6.0	
INACTIVE		7.0	9.0	8.0	6.0	6.0	11.0	5.0	22.0	14.0	
SAMPLE A		1291	1381	1672	1900	2293	2488	3001	3268	3610	
G. DRY/CC. WET MUD		0.484	0.494	0.539	0.557	0.604	0.577	0.373	0.480	0.574	
G. IR/G. DRY MUD		3.93E-10	8.49E-10	1.26E-10	1.54E-10	6.56E-10	6.63E-10	4.94E-10	2.39E-10	-80L-	
X DREDGE MATERIAL		0.397	2.732	0.000	0.000	1.743	1.779	0.912	0.000	0.000	
SAMPLE B		1292	1382	1673	1901	2294	2489	3002	3269	3611	
G. DRY/CC. WET MUD		0.601	0.593	0.583	0.569	0.591	0.558	0.437	0.515	0.450	
G. IR/G. DRY MUD		4.97E-10	5.94E-10	2.11E-10	2.96E-10	-80L-	7.70E-10	1.99E-10	6.53E-11	-80L-	
X DREDGE MATERIAL		0.929	1.424	0.000	0.000	0.000	2.327	0.000	0.000	0.000	
SAMPLE C		1293	1383	1674	1902	2295	2490	3003	3270	3612	
G. DRY/CC. WET MUD		0.594	0.567	0.496	0.549	0.525	0.536	0.469	0.627	0.507	
G. IR/G. DRY MUD		3.83E-10	3.81E-10	3.74E-10	3.16E-10	3.93E-10	1.52E-10	3.38E-10	1.75E-10	1.02E-10	
X DREDGE MATERIAL		0.345	0.333	0.296	0.000	0.396	0.000	0.112	0.000	0.000	
SAMPLE D											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
X DREDGE MATERIAL											
SAMPLE E											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
X DREDGE MATERIAL											
SAMPLE F											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
X DREDGE MATERIAL											
SAMPLE G											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
X DREDGE MATERIAL											
SAMPLE H											
G. DRY/CC. WET MUD											
G. IR/G. DRY MUD											
X DREDGE MATERIAL											

COORDINATES		HOLE LOCATION																	
A F 14 6		NO. 107		SUISUN BAY															
SAMPLING DATES		23APR74		16MAY74		17JUN74		29JUL74		13AUG74		11SEP74		10OCT74		13NOV74		11DEC74	
DEPTH OF SEDIMENT BELOW MLLW (FT)		35.0		33.0		24.5		27.0		27.0		27.0		28.0		27.5		28.0	
THICKNESS OF LAYERS (IN)		-NA- FLUFF -NA- ACTIVE -NA- INACTIVE		0.0 18.0 0.0		1.5 6.0 6.0		2.0 3.0 5.0		0.5 6.0 6.0		0.0 1.0 12.0		2.0 9.0 8.0		0.0 7.0 7.0		0.0 2.0 14.0	
SAMPLE A		NO		1438		1822		2176		2380		2659		2974		3214		3436	
G. DRY/CC WET MUD		NO		0.798		0.894		0.579		1.004		0.525		0.645		0.592		0.590	
G. IR/G. DRY MUD		SAMPLE		7.78E-10		1.67E-10		3.02E-10		1.85E-10		2.60E-10		1.11E-09		1.86E-10		6.88E-10	
X DREDGE MATERIAL		2.367		0.000		0.000		0.000		0.000		0.000		4.072		0.000		1.908	
SAMPLE B		NO		1439		1823		2177		2381		2660		2975		3215		3437	
G. DRY/CC WET MUD		NO		0.608		1.513		0.672		0.503		0.671		0.594		0.799		0.217	
G. IR/G. DRY MUD		SAMPLE		7.91E-10		1.67E-10		2.05E-10		3.74E-10		4.93E-10		1.77E-09		5.65E-11		1.03E-10	
X DREDGE MATERIAL		2.437		0.000		0.000		0.000		0.298		0.908		7.444		0.000		0.000	
SAMPLE C		NO		1440		1824		2178		2382		2661		2976		3216		3438	
G. DRY/CC WET MUD		NO		0.575		1.337		0.709		0.260		0.749		0.592		0.875		0.350	
G. IR/G. DRY MUD		SAMPLE		1.34E-09		1.13E-10		3.77E-10		1.02E-10		4.35E-10		1.40E-09		-BDL -		6.15E-10	
X DREDGE MATERIAL		5.256		0.000		0.000		0.313		0.000		0.608		5.537		0.000		1.533	
SAMPLE D		NO		4612												4614		4886	
G. DRY/CC WET MUD		NO		0.834												0.603		0.650	
G. IR/G. DRY MUD		SAMPLE		5.78E-10												-BDL -		8.71E-10	
X DREDGE MATERIAL		1.342														0.000		2.848	
SAMPLE E		NO		4613															
G. DRY/CC WET MUD		NO		0.928															
G. IR/G. DRY MUD		SAMPLE		3.39E-10															
X DREDGE MATERIAL		0.117																	
SAMPLE F		NO																	
G. DRY/CC WET MUD		NO																	
G. IR/G. DRY MUD		SAMPLE																	
X DREDGE MATERIAL																			
SAMPLE G		NO																	
G. DRY/CC WET MUD		NO																	
G. IR/G. DRY MUD		SAMPLE																	
X DREDGE MATERIAL																			
SAMPLE H		NO																	
G. DRY/CC WET MUD		NO																	
G. IR/G. DRY MUD		SAMPLE																	
X DREDGE MATERIAL																			

4615  
0.609  
5.08E-10  
0.985



COORDINATES	HOLE NO.	LOCATION	SAMPLING DATES	23APR74	28MAY74	17JUN74	29JUL74	13AUG74	11SEP74	10OCT74	13NOV74	11DEC74
A C 16 7	109	SUISUN BAY										
DEPTH OF SEDIMENT BELOW MLLW (FT)			14.0	13.5	27.5	22.0	25.0	23.5	24.0	23.0	23.5	
THICKNESS OF LAYERS (IN)												
FLUFF			-NA-	-NA-	0.0	0.0	0.0	0.0	5.0	-NA-	0.0	
ACTIVE			-NA-	-NA-	5.0	9.0	13.0	15.0	0.0	-NA-	14.0	
INACTIVE			-NA-	-NA-	0.0	0.0	0.0	0.0	0.0	-NA-	0.0	
SAMPLE A												
G.DRY/CC.WET MUD			NO	NO	NO	219	231	2590	2920	NO	3403	
G.IR/G.DRY MUD			SAMPLE	SAMPLE	SAMPLE	0.743	1.345	1.054	0.854	NO	0.884	
Σ DREDGE MATERIAL						1.53E-10	8.20E-10	3.08E-10	1.05E-10	SAMPLE	2.45E-10	
						0.000	2.586	0.000	0.000		0.000	
SAMPLE B												
G.DRY/CC.WET MUD			NO	NO	NO	2120	2312	2591	2921	NO	3404	
G.IR/G.DRY MUD			SAMPLE	SAMPLE	SAMPLE	1.325	1.491	1.350	1.370	NO	0.934	
Σ DREDGE MATERIAL						-BOL-	2.73E-10	2.08E-10	2.46E-10	SAMPLE	-BOL-	
						0.000	0.000	0.000	0.000		0.000	
SAMPLE C												
G.DRY/CC.WET MUD			NO	NO	NO	2121	2313	2592	2922	NO	3405	
G.IR/G.DRY MUD			SAMPLE	SAMPLE	SAMPLE	1.767	1.499	1.493	1.420	NO	1.177	
Σ DREDGE MATERIAL						4.89E-11	8.39E-11	2.75E-10	5.91E-11	SAMPLE	1.06E-10	
						0.000	0.000	0.000	0.000		0.000	
SAMPLE D												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE E												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE F												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE G												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												
SAMPLE H												
G.DRY/CC.WET MUD												
G.IR/G.DRY MUD												
Σ DREDGE MATERIAL												

COORDINATES		HOLE NO.	LOCATION						
H C	3 B	110	SAN PABLO BAY FLATS (STAKED)						
SAMPLING DATES		10MAY74	6JUN74	10JUL74	1AUG74	5SEP74	16OCT74	12NOV74	16DEC74
DEPTH OF SEDIMENT BELOW MLLW (FT)		9.5	9.5	9.0	11.5	11.5	10.0	11.5	11.0
THICKNESS OF LAYERS (IN)									
FLUFF		1.0	0.0	3.5	1.0	0.0	2.0	1.0	1.0
ACTIVE		7.0	11.0	7.0	8.0	6.0	7.0	8.0	7.0
INACTIVE		12.0	7.0	3.0	13.0	8.0	14.0	16.0	12.0
SAMPLE A		1420	1657	1906	2296	2497	3004	3175	3589
G. DRY/CC.WET MUD		0.661	0.370	0.629	0.603	0.648	0.467	0.504	0.517
G. IR/G.DRY MUD		5.32E-10	5.96E-10	1.19E-10	-BOL-	1.30E-10	2.55E-10	2.15E-08	3.53E-11
X DREDGE MATERIAL		1.110	1.434	0.000	0.000	0.000	0.000	108.561	0.000
SAMPLE B		1421	1658	1907	2297	2498	3005	3176	3590
G. DRY/CC.WET MUD		0.549	0.579	0.568	0.617	0.613	0.437	0.592	0.495
G. IR/G.DRY MUD		1.30E-09	7.57E-10	2.47E-10	1.94E-10	1.18E-10	1.46E-09	6.13E-10	4.63E-10
X DREDGE MATERIAL		5.041	2.263	0.000	0.000	0.000	5.857	1.523	0.755
SAMPLE C		1422	1659	1908	2298	2499	3006	3177	3591
G. DRY/CC.WET MUD		0.581	0.556	0.552	0.532	0.580	0.630	0.635	0.452
G. IR/G.DRY MUD		7.95E-10	5.14E-10	9.26E-11	4.35E-12	1.33E-10	9.45E-11	6.71E-10	1.68E-10
X DREDGE MATERIAL		2.455	1.015	0.000	0.000	0.000	0.000	1.819	0.000
SAMPLE D		4616						4795	4797
G. DRY/CC.WET MUD		0.539						0.622	0.584
G. IR/G.DRY MUD		-BOL-						1.57E-10	3.12E-10
X DREDGE MATERIAL		0.000						0.000	0.000
SAMPLE E		4617							
G. DRY/CC.WET MUD		0.573							
G. IR/G.DRY MUD		-BOL-							
X DREDGE MATERIAL		0.000							
SAMPLE F									
G. DRY/CC.WET MUD									
G. IR/G.DRY MUD									
X DREDGE MATERIAL									
SAMPLE G									
G. DRY/CC.WET MUD									
G. IR/G.DRY MUD									
X DREDGE MATERIAL									
SAMPLE H									
G. DRY/CC.WET MUD									
G. IR/G.DRY MUD									
X DREDGE MATERIAL									

COORDINATES		HOLE	LOCATION											
D J 10 1		111	CARQUINEZ STRAIT											
SAMPLING DATES		24MAY74	11JUN74	30JUL74	13AUG74	11SEP74	10OCT74	14NOV74	12DEC74					
DEPTH OF SEDIMENT BELOW MLLW (FT)		4.0	5.5	4.0	5.5	4.5	4.5	5.0	5.0					
THICKNESS OF LAYERS (IN)														
FLUFF		2.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0					
ACTIVE		8.0	4.0	10.0	8.0	8.0	9.0	6.0	6.0					
INACTIVE		6.0	17.0	8.0	5.0	9.0	8.0	11.0	15.0					
SAMPLE A		1567	1723	2128	2314	2629	2812	3232	3421					
G. DRY/CC. WET MUD		0.847	0.850	0.913	0.777	0.718	0.633	0.566	0.695					
G. IR/G. DRY MUD		3.87E-10	1.79E-10	2.76E-10	7.11E-11	7.49E-10	2.26E-10	4.50E-10	1.44E-10					
Σ DREDGE MATERIAL		0.362	0.000	0.000	0.000	2.220	0.000	0.685	0.000					
SAMPLE B		1568	1724	2129	2315	2630	2813	3233	3422					
G. DRY/CC. WET MUD		0.690	0.477	0.740	0.814	0.732	0.568	0.599	0.425					
G. IR/G. DRY MUD		1.74E-10	2.51E-10	2.25E-10	6.70E-11	5.48E-09	2.50E-10	1.33E-10	8.54E-10					
Σ DREDGE MATERIAL		0.000	0.000	0.000	0.000	26.491	0.000	0.000	2.760					
SAMPLE C		1569	1725	2130	2316	2631	2814	3234	3423					
G. DRY/CC. WET MUD		0.614	0.579	0.720	0.749	0.768	0.713	0.680	0.588					
G. IR/G. DRY MUD		2.81E-10	3.58E-10	3.71E-10	2.78E-10	5.19E-10	1.55E-10	4.39E-10	2.61E-09					
Σ DREDGE MATERIAL		0.000	0.217	0.285	0.000	1.044	0.000	0.633	11.765					
SAMPLE D		4799	4801	4803	4804	4806	4646	4807	4809					
G. DRY/CC. WET MUD		0.715	0.603	0.809	0.633	0.947	0.636	0.701	0.753					
G. IR/G. DRY MUD		-BDL	-BDL	4.54E-10	1.12E-10	-BDL	-BDL	-BDL	5.19E-11					
Σ DREDGE MATERIAL		0.000	0.000	0.709	0.000	0.000	0.000	0.000	0.000					
SAMPLE E		4800			4805	4619	4647		4810					
G. DRY/CC. WET MUD		0.687			0.859	0.724	0.736		0.780					
G. IR/G. DRY MUD		1.78E-10			-BDL	9.61E-10	2.27E-10		-BDL					
Σ DREDGE MATERIAL		0.000			0.000	3.308	0.000		0.000					
SAMPLE F		4802												
G. DRY/CC. WET MUD		0.800												
G. IR/G. DRY MUD		2.16E-10												
Σ DREDGE MATERIAL		0.000												
SAMPLE G														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														
SAMPLE H														
G. DRY/CC. WET MUD														
G. IR/G. DRY MUD														
Σ DREDGE MATERIAL														

4808  
0.706  
-BDL-  
0.000

HOPPER SAMPLES

DATA ORDERED ACCORDING TO DATE

SAMPLE NUMBER	LOCATION (CHANNEL SECTION)	DATE	TIME	GRAMS		GRAMS		PERCENT	
				IR	IN SAMPLE	IR	PER G. DRY MUD	IR IN DREDGE MATERIAL	
BACKGD 4731	--	022374	AM	2.266E-08	3.734E-09	5.066E-10	0.978	0.978	
BACKGD 4729	--	022374	PM	5.040E-08	5.024E-07	1.108E-09	4.062	4.062	
BACKGD 4727	--	022474	PM	3.903E-08	6.011E-09	7.806E-10	2.382	2.382	
BACKGD 4728	A	022474	AM	4.508E-08	1.145E-07	9.930E-10	3.472	3.472	
BACKGD 4730	A	022574	PM	8.153E-08	3.734E-09	1.631E-09	6.742	6.742	
BACKGD 4679	A	022674	AM	6.369E-08	5.024E-07	1.274E-09	4.912	4.912	
BACKGD 4676	A	022674	PM	3.432E-08	3.734E-09	6.865E-10	1.900	1.900	
BACKGD 4680	A	022774	PM	8.900E-08	8.900E-08	1.780E-09	7.507	7.507	
BACKGD 4682	A	022874	AM	4.096E-08	4.096E-08	8.122E-10	2.580	2.580	
BACKGD 4681	A	022874	PM	3.052E-07	3.052E-07	6.103E-09	29.678	29.678	
BACKGD 4678	A	030174	AM	6.011E-09	6.011E-09	1.202E-10	0.	0.	
BACKGD 4677	A	030274	AM	6.516E-08	6.516E-08	1.303E-09	5.062	5.062	
BACKGD 4719	F	030574	AM	1.145E-07	1.145E-07	2.290E-09	10.123	10.123	
BACKGD 4717	F	030574	PM	3.734E-09	3.734E-09	7.467E-11	0.	0.	
BACKGD 4712	F	030674	AM	5.024E-07	5.024E-07	1.005E-08	49.907	49.907	
BACKGD 4713	F	030674	PM	2.802E-07	2.802E-07	5.605E-09	27.122	27.122	
BACKGD 4714	F	030774	AM	4.149E-08	4.149E-08	8.298E-10	2.635	2.635	
BACKGD 4716	F	030774	PM	4.228E-07	4.228E-07	8.455E-09	41.740	41.740	
BACKGD 4715	E	030874	AM	9.028E-09	9.028E-09	1.806E-10	0.	0.	
BACKGD 4718	D	030874	PM	2.012E-08	2.012E-08	4.024E-10	0.443	0.443	
BACKGD 4711	D	030974	AM	1.116E-08	1.116E-08	2.233E-10	0.	0.	
BACKGD 4707	E	030974	PM	2.798E-07	2.798E-07	5.595E-09	27.072	27.072	
BACKGD 4704	D	031074	AM	6.586E-08	6.586E-08	1.317E-09	5.134	5.134	
BACKGD 4710	D	031074	PM	7.096E-08	7.096E-08	1.412E-09	5.657	5.657	
BACKGD 4708	D	031174	AM	3.091E-08	3.091E-08	6.182E-10	1.550	1.550	
BACKGD 4709	D	031174	PM	1.462E-07	1.462E-07	2.924E-09	13.376	13.376	
BACKGD 4705	E	031274	AM	3.574E-08	3.574E-08	7.148E-10	2.045	2.045	
BACKGD 4706	D	031274	PM	1.094E-08	1.094E-08	2.188E-10	0.	0.	
BACKGD 4723	C&D*	031374	AM	3.779E-07	3.779E-07	7.559E-09	37.142	37.142	
BACKGD 4720	D	031374	PM	6.783E-08	6.783E-08	1.357E-09	5.336	5.336	

\* Interface of sections C and D

DATA ORDERED ACCORDING TO DATE

SAMPLE NUMBER	LOCATION (CHANNEL SECTION)	DATE	TIME	GRAMS IR IN SAMPLE	GRAMS IR PER G. DRY MUD	PERCENT IR IN DREDGE MATERIAL
BACKGD 4721	D	031474	AM	8.090E-09	1.618E-10	0.
BACKGD 4722	A	031474	PM	9.521E-08	1.942E-09	8.340
BACKGD 4724	B	031574	AM	3.941E-08	7.882E-10	2.422
BACKGD 4725	A	031574	PM	7.472E-08	1.494E-09	6.043
BACKGD 4726	B	031674	AM	4.967E-08	9.984E-10	3.500
BACKGD 4693	F	031874	PM	1.124E-07	2.248E-09	9.908
BACKGD 4696	E	031974	AM	1.268E-07	2.537E-09	11.389
BACKGD 4687	F	031974	PM	2.681E-07	5.362E-09	25.879
BACKGD 4685	F	032074	AM	1.369E-08	2.739E-10	0.
BACKGD 4694	E	032074	PM	5.529E-08	1.106E-09	4.050
BACKGD 4695	F	032174	AM	2.697E-07	5.395E-09	26.045
BACKGD 4689	F	032174	PM	1.042E-07	2.084E-09	9.068
BACKGD 4684	F	032274	AM	8.945E-08	1.789E-09	7.553
BACKGD 4697	F	032274	PM	4.553E-08	9.105E-10	3.049
BACKGD 4691	E	032374	AM	4.814E-08	9.628E-10	3.317
BACKGD 4700	E	032474	AM	1.060E-07	2.120E-09	9.252
BACKGD 4698	D	032474	PM	5.061E-08	1.012E-09	3.570
BACKGD 4688	D	032574	AM	2.570E-07	5.140E-09	24.738
BACKGD 4690	D	032674	AM	4.130E-08	8.260E-10	2.615
BACKGD 4683	D	032674	PM	7.275E-08	1.455E-09	5.842
BACKGD 4702	C	032774	AM	2.787E-07	5.573E-09	26.960
BACKGD 4686	C	032774	PM	1.990E-08	3.980E-10	0.421
BACKGD 4703	C	032874	AM	1.595E-07	3.189E-09	14.735
BACKGD 4701	C	032874	PM	2.533E-07	5.085E-09	24.355
BACKGD 4692	B	032974	AM	5.799E-08	1.160E-09	4.327
BACKGD 4699	A	032974	PM	2.439E-07	4.858E-09	23.292

CENTRAL AND SOUTH BAY SAMPLES (OUTSIDE TEST AREA)

DATA ORDERED ACCORDING TO HOLE NUMBER

SAMPLE NUMBER	DEPTH*	HOLE NUMBER	COORDINATE LOCATION	LATE	GRAMS IR IN SAMPLE	GRAMS IR PER G. DRY MUD	PERCENT IR IN DREDGE MATERIAL	GRAMS DRY/CC WET MUD
SAMPLE 4001	A	H142	NA0602	092474	-BDL-	-BDL-	0.	1.222E+00
SAMPLE 4002	B	H142	NA0602	092474	3.957E-10	1.387E-11	0.	9.266E-01
SAMPLE 4003	C	H142	NA0602	092474	1.563E-08	4.466E-10	0.670	9.249E-01
SAMPLE 4856	D	H142	NA0602	092474	-BDL-	-BDL-	0.	7.902E-01
SAMPLE 4010	A	H143	GA0205	092474	2.304E-08	1.002E-09	3.517	6.071E-01
SAMPLE 4011	B	H143	GA0205	092474	1.301E-08	6.508E-10	1.717	5.506E-01
SAMPLE 4012	C	H143	GA0205	092474	1.858E-10	9.292E-12	0.	4.326E-01
SAMPLE 4004	A	H144	EI0109	092474	1.365E-08	3.903E-10	0.381	4.821E-01
SAMPLE 4005	B	H144	EI0109	092474	-BDL-	-BDL-	0.	3.983E-01
SAMPLE 4006	C	H144	EI0109	092474	-BDL-	-BDL-	0.	5.123E-01
SAMPLE 4007	A	H145	AI0104	092774	6.238E-09	1.782E-10	0.	6.139E-01
SAMPLE 4008	B	H145	AI0104	092774	2.936E-09	8.381E-11	0.	3.635E-01
SAMPLE 4009	C	H145	AI0104	092774	-BDL-	-BDL-	0.	4.427E-01
SAMPLE 4013	A	H146	FD0208	092774	1.128E-08	4.512E-10	0.693	6.694E-01
SAMPLE 4014	B	H146	FD0208	092774	1.393E-08	5.578E-10	1.240	3.639E-01
SAMPLE 4015	C	H146	FD0208	092774	3.158E-08	1.170E-09	4.380	5.425E-01
SAMPLE 4857	D	H146	FD0208	092774	2.135E-08	4.270E-10	0.569	5.412E-01
SAMPLE 4858	G	H147	JD0203	092774	7.689E-09	1.538E-10	0.	5.102E-01
SAMPLE 4016	A	H147	JD0203	102974	2.006E-08	8.083E-10	2.525	1.383E+00
SAMPLE 4017	B	H147	JD0203	102974	1.668E-08	5.096E-10	0.973	6.427E-01
SAMPLE 4019	A	H148	GA0005	102974	9.928E-09	1.984E-10	0.	7.533E-01
SAMPLE 4020	B	H148	GA0005	102974	9.500E-09	1.900E-10	0.	4.805E-01
SAMPLE 4021	C	H148	GA0005	102974	1.267E-06	2.534E-10	0.	4.143E-01
SAMPLE 4022	A	H149	CE0103	103074	2.649E-08	5.099E-10	1.097	6.897E-01
SAMPLE 4023	B	H149	CE0103	103074	1.613E-09	3.225E-11	0.	9.438E-01
SAMPLE 4024	C	H149	CE0103	103074	4.607E-10	9.215E-12	0.	9.442E-01
SAMPLE 4025	A	H150	AB0108	103074	9.033E-09	1.807E-10	0.	8.063E-01
SAMPLE 4026	B	H150	AB0108	103074	4.847E-09	9.694E-11	0.	5.924E-01

Note: BDL = Below detectable limits.

\* A = 0-25.4 mm (0-1 in.).

B = 25.4-127 mm (1-5 in.).

C = 127-229 mm (5-9 in.).

D = 229-330 mm (9-13 in.).

G = 533-635 mm (21-25 in.).

DATA ORDERED ACCORDING TO HOLE NUMBER

SAMPLE NUMBER	DEPTH	HOLE NUMBER	COORDINATE LOCATION	DATE	GRAMS IN SAMPLE	GRAMS IR PER G. DRY MUD	PERCENT IR IN DREDED MATERIAL	GRAMS DRY/ CC WET MUD
SAMPLE 4027	C	H150	AB0108	103074	1.498E-08	2.996E-10	0.	5.145E-01
SAMPLE 4028	A	H151	CA0106	103174	1.058E-08	2.697E-10	0.	8.628E-01
SAMPLE 4029	B	H151	CA0106	103174	8.929E-09	2.211E-11	0.	7.373E-01
SAMPLE 4030	C	H151	CA0106	103174	1.942E-08	3.884E-10	0.371	7.864E-01
SAMPLE 4031	A	H152	BJ0608	112674	5.804E-09	1.161E-10	0.	6.735E-01
SAMPLE 4032	B	H152	BJ0608	112674	-BDL-	-BDL-	0.	6.818E-01
SAMPLE 4033	C	H152	BJ0608	112674	2.455E-09	5.996E-11	0.	6.978E-01
SAMPLE 4034	A	H153	NI0510	112674	9.152E-09	2.097E-10	0.	1.296E+00
SAMPLE 4035	B	H153	NI0510	112674	1.339E-09	2.856E-11	0.	1.605E+00
SAMPLE 4036	C	H153	NI0510	112674	6.161E-09	1.354E-10	0.	1.583E+00
SAMPLE 4037	A	H154	DB0103	112674	7.648E-09	1.530E-10	0.	5.678E-01
SAMPLE 4038	B	H154	DB0103	112674	1.638E-08	3.272E-10	0.057	5.300E-01
SAMPLE 4039	C	H154	DB0103	112674	3.930E-08	7.861E-10	2.411	6.973E-01
SAMPLE 4859	D	H154	DB0103	112674	1.972E-08	3.943E-10	0.402	8.530E-01
SAMPLE 4040	A	H155	BF0110	112674	-BDL-	-BDL-	0.	6.711E-01
SAMPLE 4041	B	H155	BF0110	112674	-BDL-	-BDL-	0.	7.330E-01
SAMPLE 4042	C	H155	BF0110	112674	-BDL-	-BDL-	0.	6.685E-01
SAMPLE 4043	A	H156	AH0210	112674	-BDL-	-BDL-	0.	5.647E-01
SAMPLE 4044	B	H156	AH0210	112674	1.733E-09	3.468E-11	0.	8.604E-01
SAMPLE 4045	C	H156	AH0210	112674	-BDL-	-BDL-	0.	9.253E-01
SAMPLE 4046	A	H157	AH0502	121974	1.117E-08	2.234E-10	0.	8.521E-01
SAMPLE 4047	B	H157	AH0502	121974	5.392E-09	1.073E-10	0.	8.126E-01
SAMPLE 4048	C	H157	AH0502	121974	5.828E-09	1.273E-10	0.	7.950E-01
SAMPLE 4049	A	H158	AG0101	121974	6.029E-09	1.330E-10	0.	6.601E-01
SAMPLE 4050	B	H158	AG0101	121974	-BDL-	-BDL-	0.	1.938E-01
SAMPLE 4051	C	H158	AG0101	121974	8.038E-10	1.907E-11	0.	3.669E-01
SAMPLE 4052	A	H159	EB0009	121974	-BDL-	-BDL-	0.	7.351E-01
SAMPLE 4053	B	H159	EB0009	121974	1.178E-08	2.820E-10	0.	6.440E-01
SAMPLE 4054	C	H159	EB0009	121974	-BDL-	-BDL-	0.	7.180E-01
SAMPLE 4055	A	H160	GD0504	121974	1.214E-08	3.186E-10	0.013	8.579E-01
SAMPLE 4056	B	H160	GD0504	121974	1.082E-08	2.538E-10	0.	8.913E-01
SAMPLE 4057	C	H160	GD0504	121974	1.347E-08	3.509E-10	0.179	5.829E-01
SAMPLE 4058	A	H161	CA0509	121974	2.428E-09	5.320E-11	0.	9.161E-01
SAMPLE 4059	B	H161	CA0509	121974	9.237E-09	2.140E-10	0.	7.623E-01
SAMPLE 4060	C	H161	CA0509	121974	1.313E-08	3.003E-10	0.	8.569E-01

MARE ISLAND STRAIT PROFILE SAMPLES

DATA ORDERED ACCORDING TO HOLE NUMBER

SAMPLE NUMBER	DEPTH*	HOLE NUMBER	COORDINATE LOCATION	DATE	GRAMS IR IN SAMPLE	GRAMS IR PER G. DRY MUD	PERCENT IR IN DREDGE MATERIAL	GRAMS DRY / CC WET MUD
SAMPLE 4127	B	H112	EJ0910	082274	-BDL-	-BDL-	0.	5.833E-01
SAMPLE 4128	C	H112	EJ0910	082274	2.894E-09	6.618E-11	0.	7.249E-01
SAMPLE 4061	B	H113	EJ0908	082674	9.673E-09	2.078E-10	0.	4.934E-01
SAMPLE 4062	C	H113	EJ0908	082674	2.693E-08	5.387E-10	1.142	5.932E-01
SAMPLE 4063	B	H114	FA0908	082274	3.604E-09	7.208E-11	0.	5.670E-01
SAMPLE 4064	C	H114	FA0908	082274	2.314E-08	4.628E-10	0.753	5.339E-01
SAMPLE 4065	B	H115	FC1003	082274	-BDL-	-BDL-	0.	5.610E-01
SAMPLE 4066	C	H115	FC1003	082274	-BDL-	-BDL-	0.	5.958E-01
SAMPLE 4067	B	H116	FC0910	082674	1.632E-09	3.578E-11	0.	5.863E-01
SAMPLE 4068	C	H116	FC0910	082674	8.703E-09	1.741E-10	0.	6.186E-01
SAMPLE 4111	B	H117	FC0910	082274	2.297E-08	4.594E-10	0.735	4.934E-01
SAMPLE 4112	C	H117	FC0910	082274	1.110E-08	2.220E-10	0.	5.687E-01
SAMPLE 4113	D	H117	FC0910	082274	-BDL-	-BDL-	0.	6.182E-01
SAMPLE 4114	E	H117	FC0910	082274	3.522E-08	7.044E-10	1.992	5.846E-01
SAMPLE 4069	B	H118	FF1010	082674	1.292E-08	2.922E-10	0.	5.850E-01
SAMPLE 4070	C	H118	FF1010	082674	1.367E-08	3.003E-10	0.	6.375E-01
SAMPLE 4123	B	H119	FF0910	082274	1.866E-08	3.732E-10	0.293	8.466E-01
SAMPLE 4124	C	H119	FF0910	082274	2.822E-08	5.643E-10	1.274	6.922E-01
SAMPLE 4125	D	H119	FF0910	082274	-BDL-	-BDL-	0.	2.112E-01
SAMPLE 4126	E	H119	FF0910	082274	2.338E-08	4.676E-10	0.777	2.224E-01
SAMPLE 4071	B	H120	FF0910	082674	1.423E-08	3.152E-10	0.	5.980E-01
SAMPLE 4072	C	H120	FF0910	082674	6.367E-09	1.405E-10	0.	6.758E-01
SAMPLE 4073	B	H121	GAL001	082774	2.400E-08	5.248E-10	1.071	7.266E-01
SAMPLE 4074	C	H121	GAL001	082774	2.180E-08	5.090E-10	0.990	9.184E-01
SAMPLE 4103	B	H122	GA0910	082774	5.005E-08	1.001E-09	3.513	5.807E-01
SAMPLE 4104	C	H122	GA0910	082774	1.546E-08	3.092E-10	0.	5.511E-01
SAMPLE 4105	D	H122	GA0910	082774	2.242E-08	4.483E-10	0.678	5.235E-01
SAMPLE 4106	E	H122	GA0910	082774	2.377E-08	4.754E-10	0.817	5.980E-01

Note: BDL = Below detectable limits.

\* B = 0-381 mm (0-15 in.).

C = 381-762 mm (15-30 in.).

D = 762-1143 mm (30-45 in.).

E = 1143-1524 mm (45-60 in.).

DATA ORDERED ACCORDING TO HOLE NUMBER

SAMPLE NUMBER	DEPTH*	HOLE NUMBER	COORDINATE LOCATION	DATE	GRAMS IR IN SAMPLE	GRAMS IR PER G. DRY MUD	PERCENT IR IN DREDGE MATERIAL	GRAMS DRY/CC WET MUD
SAMPLE 4075	B	H123	GA0909	082974	3.000E-09	7.049E-11	0.	4.444E-01
SAMPLE 4076	C	H123	GA0909	082974	-BDL-	-BDL-	0.	5.648E-01
SAMPLE 4077	B	H124	GB1001	082774	1.717E-08	3.847E-10	0.352	4.994E-01
SAMPLE 4078	C	H124	GB1001	082774	1.235E-08	2.676E-10	0.	5.216E-01
SAMPLE 4133	B	H125	GB0910	082874	8.227E-09	1.645E-10	0.	6.087E-01
SAMPLE 4134	C	H125	GB0910	082874	8.441E-09	1.689E-10	0.	6.945E-01
SAMPLE 4135	D	H125	GB0910	082874	1.927E-08	3.854E-10	0.356	3.928E-01
SAMPLE 4136	E	H125	GB0910	082874	6.842E-08	1.368E-09	5.397	4.534E-01
SAMPLE 4079	B	H126	GB0909	082974	2.303E-08	5.269E-10	1.081	3.712E-01
SAMPLE 4080	C	H126	GB0909	082974	3.044E-08	6.088E-10	1.502	3.983E-01
SAMPLE 4081	B	H127	GB0910	082774	7.848E-09	1.703E-10	0.	5.61E-01
SAMPLE 4082	C	H127	GB0910	082774	2.545E-08	5.630E-10	1.266	5.691E-01
SAMPLE 4107	B	H128	GC0910	082774	1.064E-08	2.127E-10	0.	3.433E-01
SAMPLE 4108	C	H128	GC0910	082774	2.218E-08	4.435E-10	0.654	3.407E-01
SAMPLE 4109	D	H128	GC0910	082774	1.280E-08	2.560E-10	0.	4.233E-01
SAMPLE 4110	E	H128	GC0910	082774	2.236E-08	4.471E-10	0.672	5.283E-01
SAMPLE 4115	B	H129	GC0909	082874	1.509E-08	3.018E-10	0.	4.526E-01
SAMPLE 4116	C	H129	GC0909	082874	4.769E-08	9.537E-10	3.270	6.216E-01
SAMPLE 4117	D	H129	GC0909	082874	2.857E-08	5.714E-10	1.310	6.276E-01
SAMPLE 4118	E	H129	GC0909	082874	2.810E-08	5.620E-10	1.261	5.485E-01
SAMPLE 4083	B	H130	GF0910	082774	1.855E-08	3.710E-10	0.282	5.093E-01
SAMPLE 4084	C	H130	GF0910	082774	3.167E-08	6.335E-10	1.628	5.627E-01
SAMPLE 4119	B	H131	GF0909	082774	1.499E-08	2.997E-10	0.	2.796E-01
SAMPLE 4120	C	H131	GF0909	082774	6.036E-09	1.207E-10	0.	2.762E-01
SAMPLE 4121	D	H131	GF0909	082774	1.353E-08	2.706E-10	0.	1.008E+00
SAMPLE 4122	E	H131	GF0909	082774	8.283E-08	1.657E-09	6.875	1.042E+00
SAMPLE 4085	B	H132	GF0909	082974	4.186E-08	8.372E-10	2.673	4.861E-01
SAMPLE 4086	C	H132	GF0909	082974	1.484E-08	2.968E-10	0.	5.790E-01
SAMPLE 4087	B	H133	GI0910	082774	4.430E-09	8.860E-11	0.	4.784E-01
SAMPLE 4088	C	H133	GI0910	082774	1.189E-08	2.378E-10	0.	5.876E-01
SAMPLE 4129	B	H134	GI0910	082774	-BDL-	-BDL-	0.	3.962E-01
SAMPLE 4130	C	H134	GI0910	082774	5.985E-08	1.197E-09	4.518	5.734E-01
SAMPLE 4131	D	H134	GI0910	082774	2.685E-08	5.670E-10	1.287	4.887E-01
SAMPLE 4132	E	H134	GI0910	082774	2.708E-08	6.227E-10	1.573	6.094E-01

DATA ORDERED ACCORDING TO HOLE NUMBER

SAMPLE NUMBER	DEPTH*	HOLE NUMBER	COORDINATE LOCATION	DATE	GRAMS IR IN SAMPLE	GRAMS IR PER G. DRY MUD	PERCENT IR IN DREDGE MATERIAL	GRAMS DRY/CC WET MUD
SAMPLE 4089	B	H135	GI0909	082974	9.648E-09	1.930E-10	0.	5.025E-01
SAMPLE 4090	C	H135	GI0909	082974	2.782E-08	5.565E-10	1.233	4.229E-01
SAMPLE 4091	B	H136	HA0910	082674	1.156E-08	2.313E-10	0.	4.844E-01
SAMPLE 4092	C	H136	HA0910	082674	2.204E-08	4.408E-10	0.640	5.868E-01
SAMPLE 4093	B	H137	HA0909	082674	9.601E-09	1.920E-10	0.	5.657E-01
SAMPLE 4094	C	H137	HA0909	082674	1.047E-08	2.095E-10	0.	7.120E-01
SAMPLE 4095	B	H138	HA0909	082674	6.398E-09	1.372E-10	0.	6.216E-01
SAMPLE 4096	C	H138	HA0909	082674	1.115E-08	2.229E-10	0.	6.156E-01
SAMPLE 4097	B	H139	HD0910	082674	1.902E-08	4.081E-10	0.473	6.263E-01
SAMPLE 4098	C	H139	HD0910	082674	7.224E-09	1.445E-10	0.	6.349E-01
SAMPLE 4099	B	H140	HD0909	082674	4.710E-09	9.419E-11	0.	5.756E-01
SAMPLE 4100	C	H140	HD0909	082674	1.413E-08	2.826E-10	0.	5.522E-01
SAMPLE 4101	B	H141	HD0909	082674	2.072E-09	4.544E-11	0.	6.229E-01
SAMPLE 4102	C	H141	HD0909	082674	3.579E-09	7.886E-11	0.	6.276E-01

INCLOSURE 3

Distribution of Dredged Sediment Volumes

VOLUME OF DREDGED MATERIAL FOR STUDY AREA

Sampling Period	Layer A (yd <sup>3</sup> )	Layer B (yd <sup>3</sup> )	Layer C (yd <sup>3</sup> )	Total (yd <sup>3</sup> )
Early March	1,414,000	8,104,000	4,001,000	13,519,000
Late March	216,000	686,000	601,000	1,503,000
April	608,000	2,142,000	1,999,000	4,749,000
May	250,000	957,000	965,000	2,172,000
June	86,000	273,000	606,000	965,000
July	291,000	653,000	437,000	1,381,000
August	47,000	213,000	101,000	361,000
September	117,000	667,000	410,000	1,194,000
October	352,000	1,600,000	1,472,000	3,424,000
November	217,000	239,000	148,000	604,000
December	148,000	476,000	252,000	876,000

SAN PABLO BAY  
VOLUME OF DREDGED MATERIAL

Sampling Period	Layer A (yd <sup>3</sup> )	Layer B (yd <sup>3</sup> )	Layer C (yd <sup>3</sup> )	Total (yd <sup>3</sup> )
April	478,000	1,614,000	1,637,600	3,729,000
May	226,000	874,000	79,000	1,893,000
June	62,000	263,000	540,000	865,000
July	275,000	622,000	382,000	1,279,000
August	34,000	156,000	60,000	250,000
September	97,000	331,000	386,000	814,000
October	325,000	1,393,000	1,349,000	3,067,000
November	140,000	215,000	140,000	495,000
December	98,000	414,000	197,000	709,000

SUISUN BAY  
VOLUME OF DREDGED MATERIAL

Sampling Period	Layer A (yd <sup>3</sup> )	Layer B (yd <sup>3</sup> )	Layer C (yd <sup>3</sup> )	Total (yd <sup>3</sup> )
April	104,000	343,000	255,000	702,000
May	16,000	34,000	81,000	131,000
June	16,000	0	34,000	50,000
July	5,000	18,000	23,000	46,000
August	10,000	47,000	18,000	75,000
September	10,000	200,000	5,000	215,000
October	18,000	73,000	68,000	159,000
November	73,000	8,000	0	81,000
December	34,000	21,000	5,000	60,000

MARE ISLAND STRAIT  
VOLUME OF DREDGED MATERIAL

Sampling Period	Layer A (yd <sup>3</sup> )	Layer B (yd <sup>3</sup> )	Layer C (yd <sup>3</sup> )	Total (yd <sup>3</sup> )
April	5,000	39,000	13,000	57,000
May	3,000	10,000	8,000	21,000
June	3,000	5,000	3,000	11,000
July	8,000	10,000	16,000	34,000
August	0	5,000	0	5,000
September	0	1,000	1,000	2,000
October	1,000	1,000	21,000	23,000
November	1,000	0	3,000	4,000
December	0	5,000	3,000	8,000

CARQUINEZ STRAIT  
VOLUME OF DREDGED MATERIAL

Sampling Period	Layer A (yd <sup>3</sup> )	Layer B (yd <sup>3</sup> )	Layer C (yd <sup>3</sup> )	Total (yd <sup>3</sup> )
April	21,000	146,000	94,000	261,000
May	5,000	39,000	83,000	127,000
June	5,000	5,000	29,000	39,000
July	3,000	3,000	16,000	22,000
August	3,000	5,000	23,000	31,000
September	10,000	135,000	18,000	163,000
October	8,000	133,000	34,000	175,000
November	3,000	16,000	5,000	24,000
December	16,000	36,000	47,000	99,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR APRIL SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
A	1	200,000			
	2		29,000		
	3	137,000			
	4		28,000		
	5			128,000	
	6	3,000			
	7	7,000			
	8		2,000		
	9		39,000		
	10	6,000			
	11	22,000			
	12	7,000			
	SUBTOTAL	382,000	98,000	128,000	608,000
B	1	760,000			
	2		127,000		
	3	355,000			
	4		93,000		
	5			504,000	
	6	8,000			
	7	51,000			
	8		11,000		
	9		124,000		
	10	18,000			
	11	68,000			
	12	23,000			
	SUBTOTAL	1,283,000	355,000	504,000	2,142,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR APRIL SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
C	1	1,021,000			
	2		159,000		
	3	193,000			
	4		46,000		
	5			361,000	
	6	14,000			
	7	28,000			
	8		5,000		
	9		92,000		
	10	13,000			
	11	51,000			
	12	16,000			
	SUBTOTAL	1,336,000	302,000	361,000	1,999,000
	TOTAL	3,001,000	755,000	993,000	4,749,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR MAY SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	>18 Ft.	
A	1	156,000			
	2		20,000		
	3	13,000			
	4				
	5		9,000		
	6	1,000		43,000	
	7	2,000			
	8				
	9		1,000		
	10	0	3,000		
	11	2,000			
	12	0			
	SUBTOTAL	174,000	33,000	43,000	250,000
B	1	376,000			
	2		139,000		
	3				
	4	134,000			
	5		80,000		
	6	3,000			
	7	14,000		198,000	
	8				
	9	0	3,000		
	10	5,000	5,000		
	11				
	12	0			
	SUBTOTAL	532,000	227,000	198,000	957,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR MAY SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
C	1	476,000			
	2		69,000		
	3	62,000			
	4		65,000		
	5			224,000	
	6	14,000			
	7	21,000			
	8				
	9		4,000		
	10	0	16,000		
	11	13,000			
	12	1,000			
	SUBTOTAL	587,000	154,000	224,000	965,000
	TOTAL	1,293,000	414,000	465,000	2,172,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR JUNE SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	>18 Ft.	
A	1	40,000			
	2		10,000		
	3	3,000			
	4		2,000		
	5			15,000	
	6	0			
	7	1,000			
	8		0		
	9		7,000		
	10	2,000			
	11	3,000			
	12	3,000			
	SUBTOTAL	52,000	19,000	15,000	86,000
B	1	85,000			
	2		40,000		
	3				
	4	77,000			
	5		25,000		
	6	1,000		45,000	
	7	0			
	8		0		
	9		0		
	10	0			
	11	0			
	12	0			
	SUBTOTAL	163,000	65,000	45,000	273,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR JUNE SAMPLING PERIOD

LAYER	AREA	DEPTH		TOTAL
		0-6 Ft.	> 18 Ft.	
C	1	157,000		
	2		145,000	
	3	71,000		
	4		56,000	
	5			146,000
	6	1,000		
	7	5,000		
	8		1,000	
	9		14,000	
	10	2,000		
	11	8,000		
	12	0		
	SUBTOTAL	244,000	216,000	606,000
	TOTAL	459,000	206,000	965,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR JULY SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
A	1	134,000			
	2		36,000		
	3	1,000			
	4		2,000		
	5			116,000	
	6	0			
	7	0			
	8		0		
	9		2,000		
	10	0			
	11	0			
	12	0			
SUBTOTAL		135,000	40,000	116,000	291,000
B	1	400,000			
	2		66,000		
	3	8,000			
	4		5,000		
	5			160,000	
	6	0			
	7	0			
	8		0		
	9		9,000		
	10	1,000			
	11	3,000			
	12	1,000			
SUBTOTAL		413,000	80,000	160,000	653,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR JULY SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
C	1	217,000			
	2		51,000		
	3				
	4	11,000			
	5		10,000		
	6	3,000		127,000	
	7	2,000			
	8				
	9				
	10	1,000			
	11	5,000			
	12	2,000			
	SUBTOTAL	241,000	69,000	127,000	437,000
	TOTAL	789,000	189,000	403,000	1,381,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR AUGUST SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	>18 Ft.	
A	1	7,000			
	2		7,000		
	3	5,000			
	4		1,000		
	5			21,000	
	6	0			
	7	0			
	8		0		
	9		1,000		
	10	0			
	11	5,000			
	12	0			
	SUBTOTAL	<u>17,000</u>	<u>9,000</u>	<u>21,000</u>	47,000
B	1	127,000			
	2		19,000		
	3	2,000			
	4		2,000		
	5			27,000	
	6	1,000			
	7	2,000			
	8		0		
	9		22,000		
	10	3,000			
	11	3,000			
	12	5,000			
	SUBTOTAL	<u>143,000</u>	<u>43,000</u>	<u>27,000</u>	213,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR AUGUST SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
C	1	22,000			
	2		13,000		
	3	10,000			
	4		6,000		
	5			27,000	
	6	8,000			
	7	2,000			
	8		0		
	9		9,000		
	10	1,000			
	11	2,000			
	12	1,000			
	SUBTOTAL	46,000	28,000	27,000	101,000
	TOTAL	206,000	80,000	75,000	361,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR SEPTEMBER SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
A	1	50,000			
	2		24,000		
	3	2,000			
	4		11,000		
	5			19,000	
	6	1,000			
	7	1,000			
	8		1,000		
	9		4,000		
	10	1,000			
	11	2,000			
	12	1,000			
	SUBTOTAL	58,000	40,000	19,000	117,000
B	1	237,000			
	2		36,000		
	3	11,000			
	4		11,000		
	5			196,000	
	6	3,000			
	7	3,000			
	8		0		
	9		93,000		
	10	16,000			
	11	36,000			
	12	25,000			
	SUBTOTAL	331,000	140,000	196,000	667,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR SEPTEMBER SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
C	1	155,000			
	2		67,000		
	3	12,000			
	4		65,000		
	5			104,000	
	6	1,000			
	7	5,000			
	8		0		
	9		0		
	10	0			
	11	1,000			
	12	0			
	SUBTOTAL	174,000	132,000	104,000	410,000
	TOTAL	563,000	312,000	319,000	1,194,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR OCTOBER SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
A	1	110,000			
	2		50,000		
	3	21,000			
	4		10,000		
	5			145,000	
	6	1,000			
	7	4,000			
	8		0		
	9		6,000		
	10	1,000			
	11	3,000			
	12	1,000			
	SUBTOTAL	141,000	66,000	145,000	352,000
B	1	244,000			
	2		160,000		
	3	359,000			
	4		184,000		
	5			544,000	
	6	6,000			
	7	73,000			
	8				
	9				
	10	1,000			
	11	10,000			
	12	1,000			
	SUBTOTAL	694,000	362,000	544,000	1,600,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR OCTOBER SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	>18 Ft.	
C	1	288,000			
	2		150,000		
	3	421,000			
	4		135,000		
	5			418,000	
	6	0			
	7	23,000			
	8		0		
	9		20,000		
	10	3,000			
	11	12,000			
	12	2,000			
	SUBTOTAL	749,000	305,000	418,000	1,472,000
	TOTAL	1,584,000	733,000	1,107,000	3,424,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR NOVEMBER SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	> 18 Ft.	
A	1	55,000			
	2		73,000		
	3	2,000			
	4		2,000		
	5			29,000	
	6	0			
	7	0			
	8		0		
	9		38,000		
	10	4,000			
	11	13,000			
	12	1,000			
	SUBTOTAL	<u>75,000</u>	<u>113,000</u>	<u>29,000</u>	217,000
B	1	104,000			
	2		19,000		
	3	11,000			
	4		5,000		
	5			90,000	
	6	6,000			
	7	1,000			
	8		0		
	9		3,000		
	10	0			
	11	0			
	12	0			
	SUBTOTAL	<u>122,000</u>	<u>27,000</u>	<u>90,000</u>	239,000

AD-A043 790

CORPS OF ENGINEERS SAN FRANCISCO CALIF SAN FRANCISCO--ETC F/G 13/2  
DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)  
AUG 77 J F SUSTAR, R M ECKER, W T HARVEY

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5 OF 7

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A043 790



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VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR NOVEMBER SAMPLING PERIOD

LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	>18 Ft.	
C	1				
	2	109,000	12,000		
	3				
	4	4,000	2,000		
	5			21,000	
	6	0			
	7	0			
	8		0		
	9		0		
	10	0			
	11	0			
	12	0			
	SUBTOTAL	113,000	14,000	21,000	148,000
	TOTAL	310,000	154,000	140,000	604,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR DECEMBER SAMPLING PERIOD

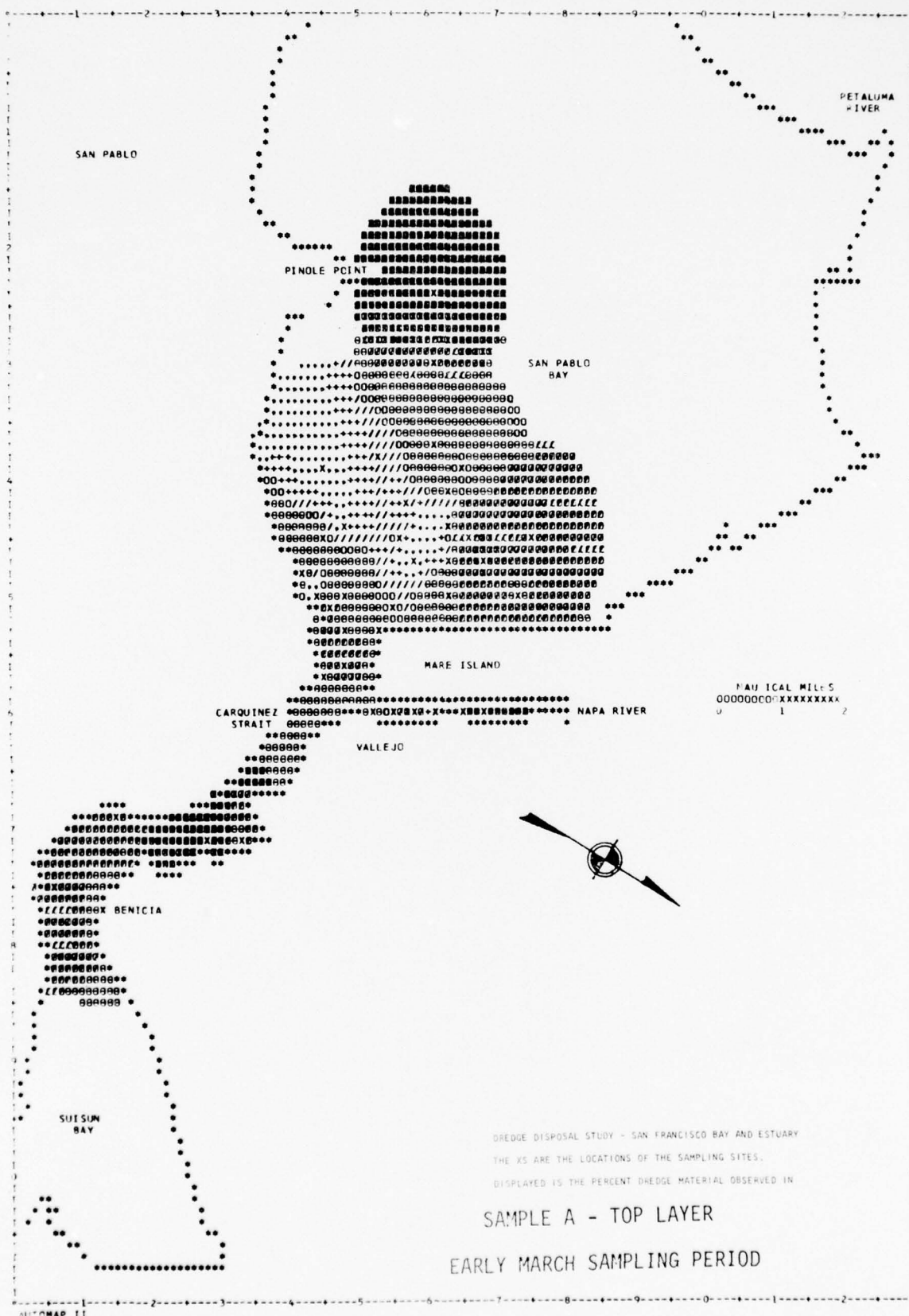
LAYER	AREA	DEPTH			TOTAL
		0-6 Ft.	6-18 Ft.	>18 Ft.	
A	1	81,000			
	2		1,000		
	3	9,000			
	4		3,000		
	5			19,000	
	6	4,000			
	7	2,000			
	8		0		
	9		15,000		
	10	4,000			
	11	3,000			
	12	7,000			
	SUBTOTAL	110,000	19,000	19,000	148,000
B	1	385,000			
	2		15,000		
	3				
	4	7,000			
	5		3,000		
	6	1,000			
	7	14,000			
	8			33,000	
	9				
	10	2,000			
	11	3,000			
	12	3,000			
	SUBTOTAL	415,000	28,000	33,000	476,000

VOLUMES (YD<sup>3</sup>) OF DREDGED MATERIAL BY DEPTH, LAYER,  
AND AREA FOR DECEMBER SAMPLING PERIOD (cont'd)

LAYER	AREA	DEPTH		TOTAL
		0-6 Ft.	6-18 Ft.	
C	1	134,000		
	2		22,000	
	3	6,000		
	4			
	5		22,000	65,000
	6	1,000		
	7	1,000		
	8		0	
	9		0	
	10	0		
	11	1,000		
	12	0		
	SUBTOTAL	143,000	44,000	65,000
	TOTAL	668,000	91,000	117,000
				252,000
				876,000

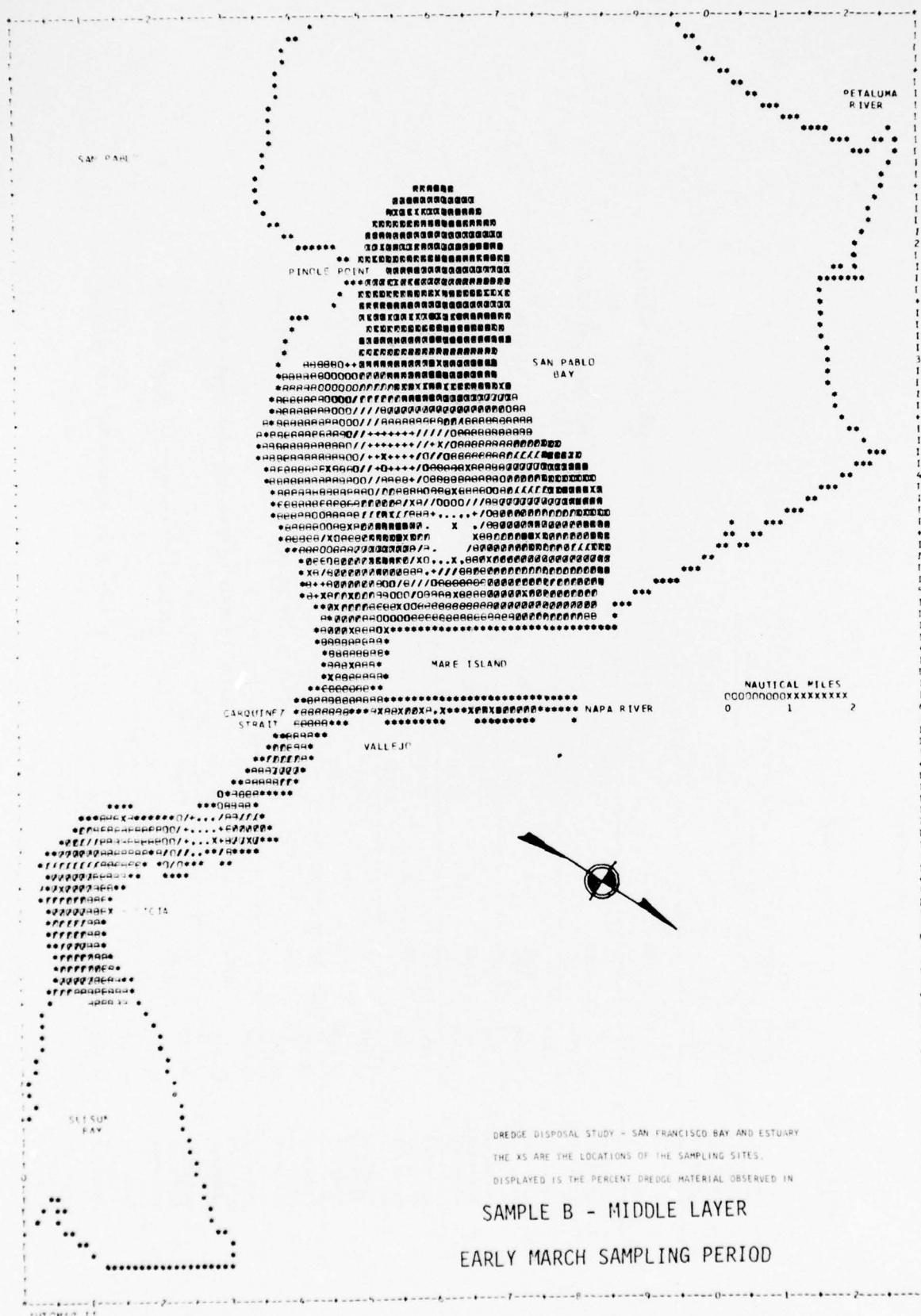
INCLOSURE 4

Graphical Displays of Percent  
Dredged Material for Layers A,B, and C



SAMPLE A - TOP LAYER  
EARLY MARCH SAMPLING PERIOD

DATA VALUE EXTREMES ARE				0.000	99.000		
LEV-L NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
1	LLLLLLL LLLLLLL LLLLLLL	0.000 0.000 0.000	0.00 0.00 0.00	0	0.00 0.00 0.00	0.00	
1		0.000 .500	0.00 .50	3	0.00 7.69	7.69	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2	..... ..... .....	.500 2.000	.50 1.50	1	7.69 10.26	2.56	ONE HALF TO TWO PER CENT DREDGE MATERIAL
3	..... ..... .....	2.000 4.000	2.00 4.00	2	10.26 15.38	5.13	TWO TO FOUR PER CENT DREDGE MATERIAL
4	+++++++ +++++++ +++++++	4.000 6.000	2.00 2.00	2	15.38 20.51	5.13	FOUR TO SIX PER CENT DREDGE MATERIAL
5	///////// ///////// /////////	6.000 8.000	2.00 2.00	2	20.51 25.64	5.13	SIX TO EIGHT PER CENT DREDGE MATERIAL
6	00000000 00000000 00000000	8.000 10.000	2.00 2.00	3	25.64 33.33	7.69	EIGHT TO TEN PER CENT DREDGE MATERIAL
7	88888888 88888888 88888888	10.000 20.000	10.00 10.00	14	33.33 69.23	35.90	TEN TO TWENTY PER CENT DREDGE MATERIAL
8	22222222 22222222 22222222	20.000 40.000	20.00 20.00	6	69.23 84.62	15.38	TWENTY TO FORTY PER CENT DREDGE MATERIAL
9	33333333 33333333 33333333	40.000 80.000	40.00 40.00	3	84.62 92.31	7.69	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10	55555555 55555555 55555555	80.000 100.000	20.00 20.00	3	92.31 100.00	7.69	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHHH HHHHHHHH HHHHHHHH	100.000 100.000	100.00 100.00	0	100.00 100.00	0.00	



SAMPLE B MIDDLE LAYER  
EARLY MARCH SAMPLING PERIOD

DATA VALUE EXTREMES ARE 0.000 99.000

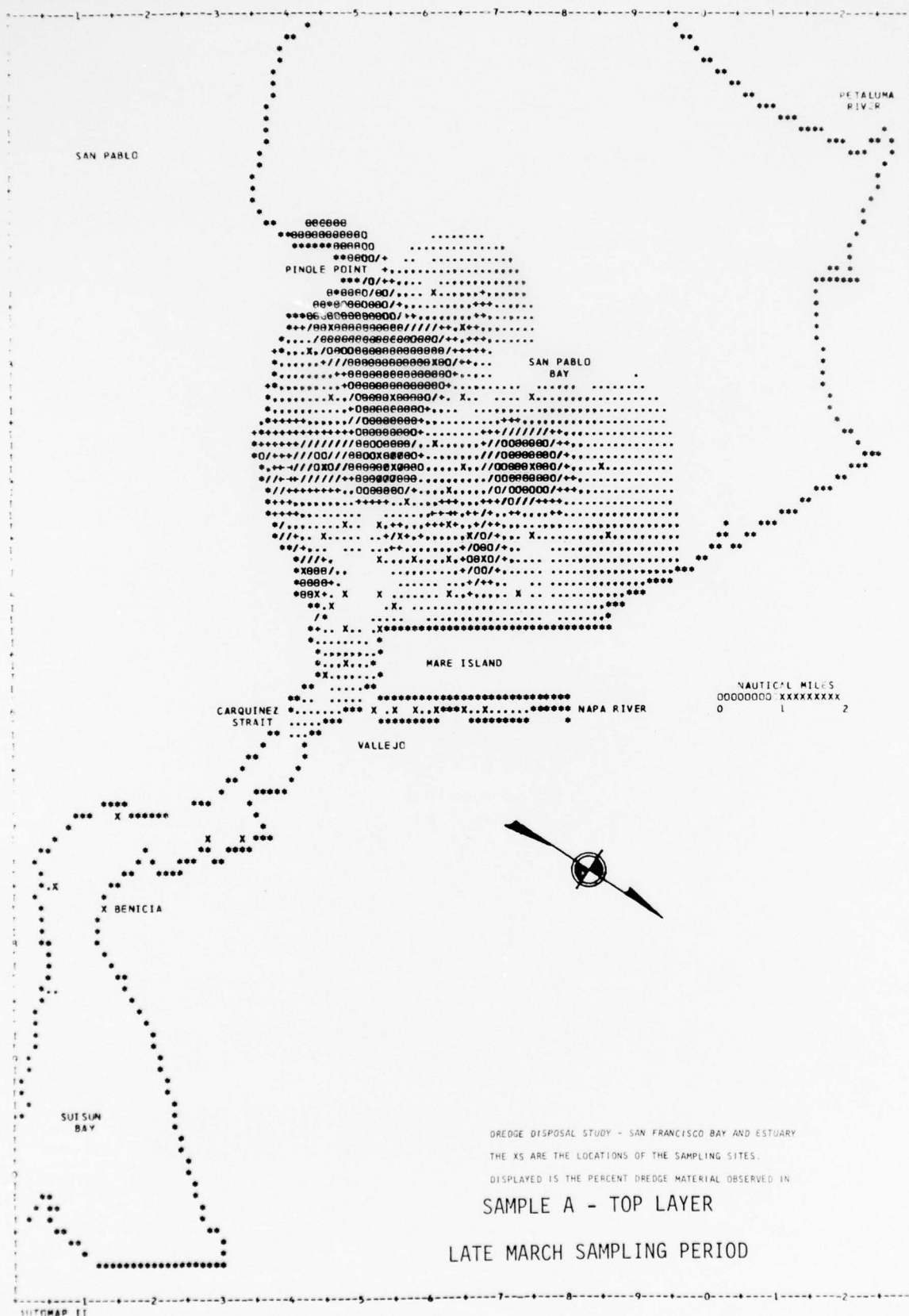
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000 0.000		0	0.00 0.00 0.00	0.00
1		0.000 .500 2.000	.50 1.50 2.00	5 3 0	0.00 12.82 20.51	12.82 12.82 7.69
2		.500 2.000 4.000	1.50 2.00 2.00	3 0 0	12.82 20.51 20.51	7.69 0.00 0.00
3		2.000 4.000 6.000	2.00 2.00 2.00	0 3 1	20.51 20.51 28.21	0.00 7.69 2.56
4		4.000 6.000 8.000	2.00 2.00 2.00	3 1 1	20.51 28.21 30.77	7.69 2.56 5.13
5		6.000 8.000 10.000	2.00 2.00 2.00	2 12 12	30.77 35.90 35.90	5.13 30.77 20.51
6		10.000 20.000 40.000	10.00 10.00 20.00	8 8 3	66.67 66.67 87.18	20.51 7.69 5.13
7		20.000 40.000 80.000	20.00 40.00 20.00	2 3 2	87.18 94.87 94.87	5.13 0.00 0.00
8		40.000 80.000 100.000	40.00 20.00 100.00	0 0 0	100.00 100.00 100.00	
HIGH	HHHHHHH HHHHHHH HHHHHHH	100.000 100.000 100.000		0	100.00 100.00 100.00	0.00



SAMPLE C BOTTOM LAYER  
EARLY MARCH SAMPLING PERIOD

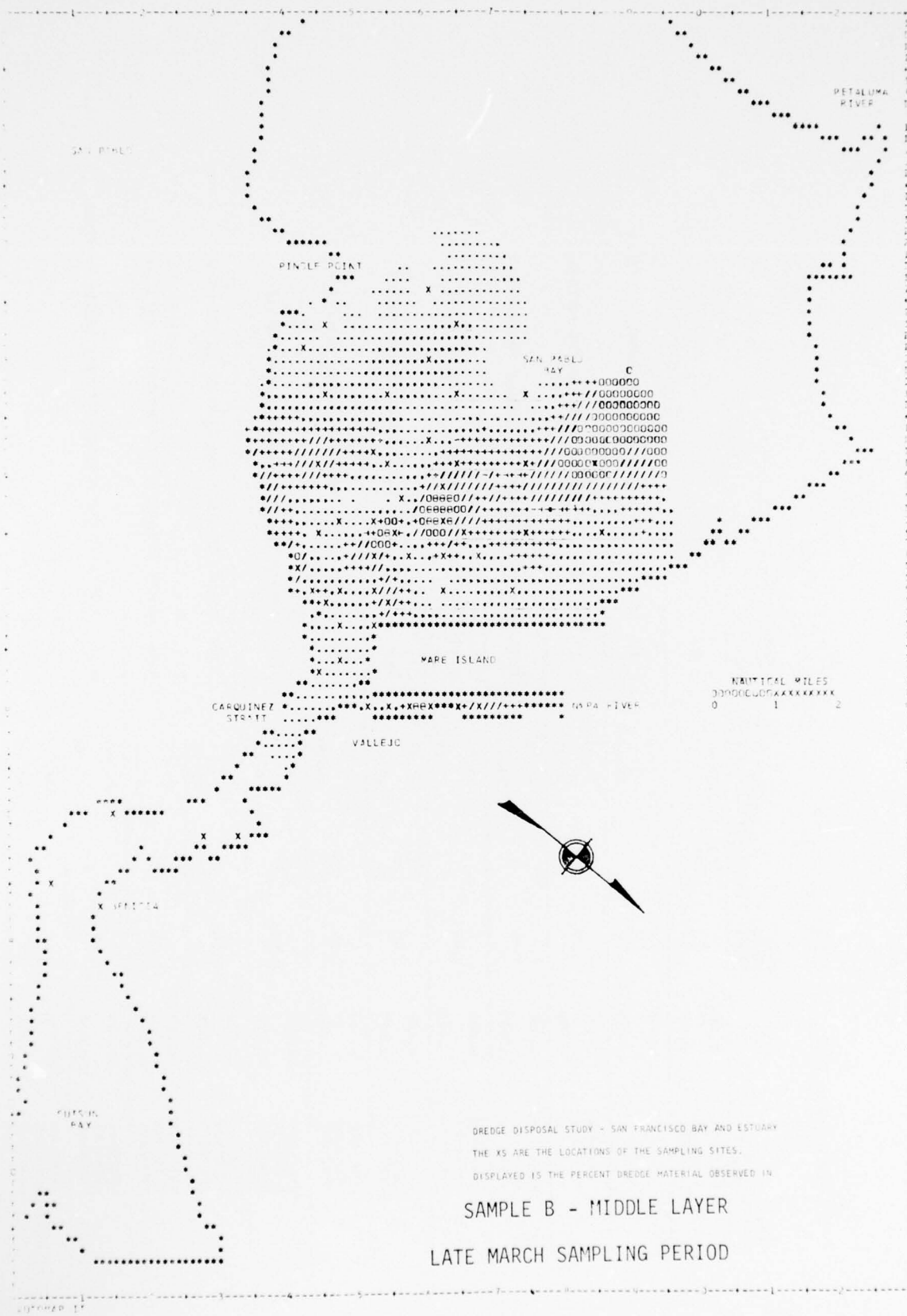
DATA: VALUE EXTREMES ARE 0.000 64.640

LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL	0.000	0.000	0	0.00	0.00	
1	*****	0.000	0.50	6	0.00	15.38	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2	*****	0.500	1.50	2	15.38	5.13	ONE HALF TO TWO PER CENT DREDGE MATERIAL
3	*****	2.000	2.00	1	20.51	2.56	TWO TO FOUR PER CENT DREDGE MATERIAL
4	*****	4.000	2.00	2	23.08	5.13	FOUR TO SIX PER CENT DREDGE MATERIAL
5	*****	6.000	2.00	3	28.21	7.69	SIX TO EIGHT PER CENT DREDGE MATERIAL
6	*****	8.000	2.00	4	35.90	10.26	EIGHT TO TEN PER CENT DREDGE MATERIAL
7	*****	10.000	10.00	11	46.15	28.21	TEN TO TWENTY PER CENT DREDGE MATERIAL
8	*****	20.000	23.00	6	74.36	15.38	TWENTY TO FORTY PER CENT DREDGE MATERIAL
9	*****	40.000	40.00	4	89.74	10.26	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10	*****	80.000	23.00	0	100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHHH	100.000		0	100.00	0.00	



SAMPLE A - TOP LAYER  
LATE MARCH SAMPLING PERIOD

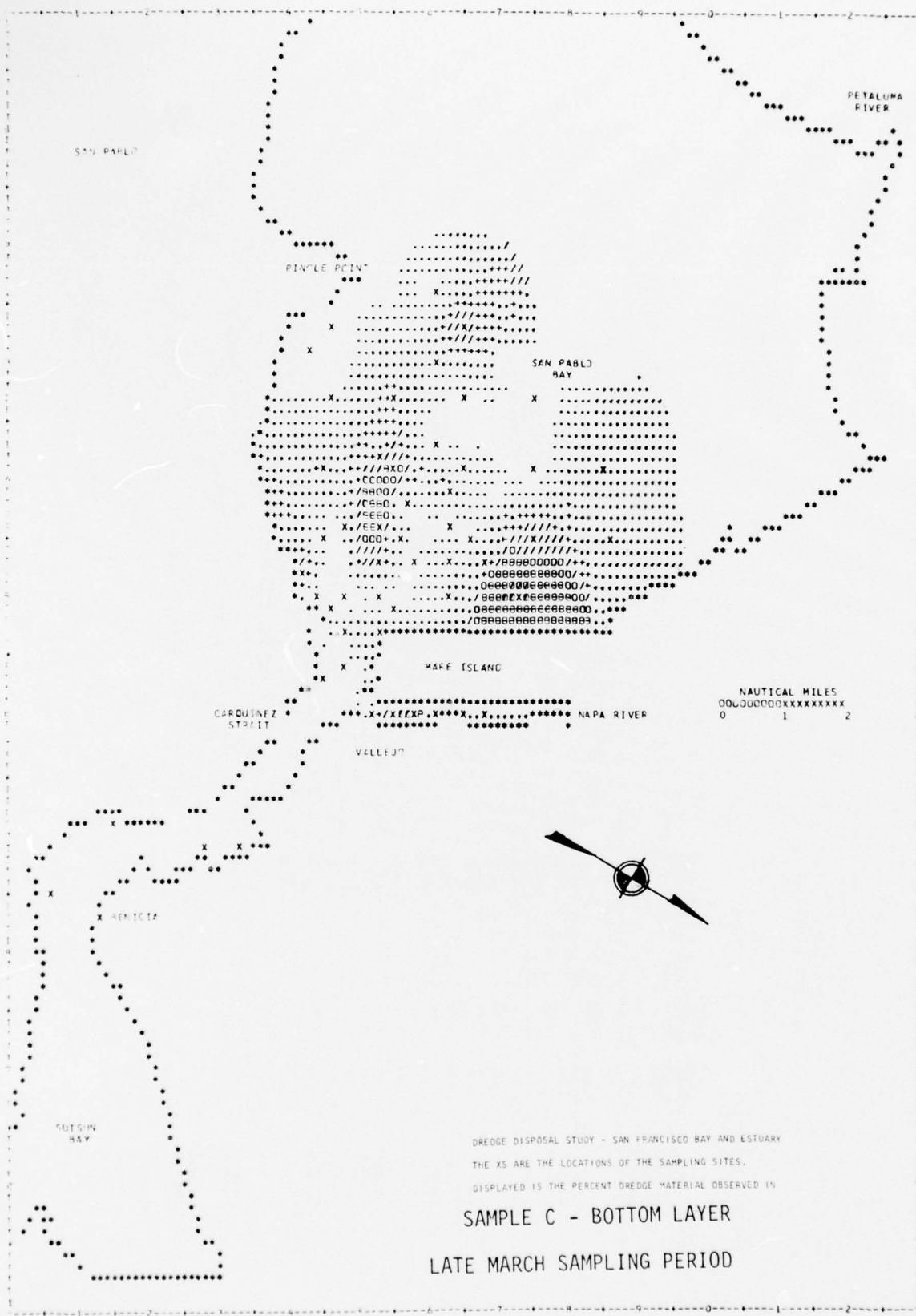
DATA VALUE EXTREMES ARE		0.003	30.990			
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
1	LLLLLLLL	0.000		0	0.00	0.00
	LLLLLLLL	0.000			0.00	
1		0.000		21	0.00	39.62
		.500	.50		39.62	
2	.....	.500		11	39.62	20.75
	.....	2.000	1.50		60.38	
3	.....	2.000		9	60.38	16.98
	.....	4.000	2.00		77.36	
4	++++++	4.000		1	77.36	1.89
	++++++	6.000	2.00		79.25	
5	////////	6.000		3	79.25	5.66
	////////	8.000	2.00		84.91	
6	00000000	8.000		1	84.91	1.89
	00000000	10.000	2.00		86.79	
7	88888888	10.000		5	86.79	9.43
	88888888	20.000	10.00		96.23	
8	99999999	20.000		2	96.23	3.77
	99999999	40.000	20.00		100.00	
9	99999999	40.000		0	100.00	0.00
	99999999	80.000	40.00		100.00	
10	99999999	80.000		0	100.00	0.00
	99999999	100.000	20.00		100.00	
HTGH	HHHHHHHH	100.000		0	100.00	0.00
	HHHHHHHH	100.000			100.00	



DREDGE DISPOSAL STUDY - SAN FRANCISCO BAY AND ESTUARY  
 THE XS ARE THE LOCATIONS OF THE SAMPLING SITES.  
 DISPLAYED IS THE PERCENT DREDGE MATERIAL OBSERVED IN  
 SAMPLE B - MIDDLE LAYER  
 LATE MARCH SAMPLING PERIOD

SAMPLE H - MIDDLE LAYER  
LATE MARCH SAMPLING PERIOD

DATA VALUE EXTREMES ARE		0.00	16.244	
LEVEL NUMBER	SYMBOL	VALUE RANGE	FREQUENCY	PERCENT OF AREAS
1	LLLLLLL	0.000	0	0.00
2	LLLLLLL	0.000	0	0.00
3	LLLLLLL	0.000	0	0.00
4	LLLLLLL	0.000	0	0.00
5	LLLLLLL	0.000	0	0.00
6	LLLLLLL	0.000	0	0.00
7	LLLLLLL	0.000	0	0.00
8	LLLLLLL	0.000	0	0.00
9	LLLLLLL	0.000	0	0.00
10	LLLLLLL	0.000	0	0.00
11	LLLLLLL	0.000	0	0.00
12	LLLLLLL	0.000	0	0.00
13	LLLLLLL	0.000	0	0.00
14	LLLLLLL	0.000	0	0.00
15	LLLLLLL	0.000	0	0.00
16	LLLLLLL	0.000	0	0.00
17	LLLLLLL	0.000	0	0.00
18	LLLLLLL	0.000	0	0.00
19	LLLLLLL	0.000	0	0.00
20	LLLLLLL	0.000	0	0.00
21	LLLLLLL	0.000	0	0.00
22	LLLLLLL	0.000	0	0.00
23	LLLLLLL	0.000	0	0.00
24	LLLLLLL	0.000	0	0.00
25	LLLLLLL	0.000	0	0.00
26	LLLLLLL	0.000	0	0.00
27	LLLLLLL	0.000	0	0.00
28	LLLLLLL	0.000	0	0.00
29	LLLLLLL	0.000	0	0.00
30	LLLLLLL	0.000	0	0.00
31	LLLLLLL	0.000	0	0.00
32	LLLLLLL	0.000	0	0.00
33	LLLLLLL	0.000	0	0.00
34	LLLLLLL	0.000	0	0.00
35	LLLLLLL	0.000	0	0.00
36	LLLLLLL	0.000	0	0.00
37	LLLLLLL	0.000	0	0.00
38	LLLLLLL	0.000	0	0.00
39	LLLLLLL	0.000	0	0.00
40	LLLLLLL	0.000	0	0.00
41	LLLLLLL	0.000	0	0.00
42	LLLLLLL	0.000	0	0.00
43	LLLLLLL	0.000	0	0.00
44	LLLLLLL	0.000	0	0.00
45	LLLLLLL	0.000	0	0.00
46	LLLLLLL	0.000	0	0.00
47	LLLLLLL	0.000	0	0.00
48	LLLLLLL	0.000	0	0.00
49	LLLLLLL	0.000	0	0.00
50	LLLLLLL	0.000	0	0.00
51	LLLLLLL	0.000	0	0.00
52	LLLLLLL	0.000	0	0.00
53	LLLLLLL	0.000	0	0.00
54	LLLLLLL	0.000	0	0.00
55	LLLLLLL	0.000	0	0.00
56	LLLLLLL	0.000	0	0.00
57	LLLLLLL	0.000	0	0.00
58	LLLLLLL	0.000	0	0.00
59	LLLLLLL	0.000	0	0.00
60	LLLLLLL	0.000	0	0.00
61	LLLLLLL	0.000	0	0.00
62	LLLLLLL	0.000	0	0.00
63	LLLLLLL	0.000	0	0.00
64	LLLLLLL	0.000	0	0.00
65	LLLLLLL	0.000	0	0.00
66	LLLLLLL	0.000	0	0.00
67	LLLLLLL	0.000	0	0.00
68	LLLLLLL	0.000	0	0.00
69	LLLLLLL	0.000	0	0.00
70	LLLLLLL	0.000	0	0.00
71	LLLLLLL	0.000	0	0.00
72	LLLLLLL	0.000	0	0.00
73	LLLLLLL	0.000	0	0.00
74	LLLLLLL	0.000	0	0.00
75	LLLLLLL	0.000	0	0.00
76	LLLLLLL	0.000	0	0.00
77	LLLLLLL	0.000	0	0.00
78	LLLLLLL	0.000	0	0.00
79	LLLLLLL	0.000	0	0.00
80	LLLLLLL	0.000	0	0.00
81	LLLLLLL	0.000	0	0.00
82	LLLLLLL	0.000	0	0.00
83	LLLLLLL	0.000	0	0.00
84	LLLLLLL	0.000	0	0.00
85	LLLLLLL	0.000	0	0.00
86	LLLLLLL	0.000	0	0.00
87	LLLLLLL	0.000	0	0.00
88	LLLLLLL	0.000	0	0.00
89	LLLLLLL	0.000	0	0.00
90	LLLLLLL	0.000	0	0.00
91	LLLLLLL	0.000	0	0.00
92	LLLLLLL	0.000	0	0.00
93	LLLLLLL	0.000	0	0.00
94	LLLLLLL	0.000	0	0.00
95	LLLLLLL	0.000	0	0.00
96	LLLLLLL	0.000	0	0.00
97	LLLLLLL	0.000	0	0.00
98	LLLLLLL	0.000	0	0.00
99	LLLLLLL	0.000	0	0.00
100	LLLLLLL	0.000	0	0.00



DREDGE DISPOSAL STUDY - SAN FRANCISCO BAY AND ESTUARY  
 THE XS ARE THE LOCATIONS OF THE SAMPLING SITES.  
 DISPLAYED IS THE PERCENT DREDGE MATERIAL OBSERVED IN  
**SAMPLE C - BOTTOM LAYER**  
**LATE MARCH SAMPLING PERIOD**

SAMPLE C BOTTOM LAYER  
LATE MARCH SAMPLING PERIOD

DATA VALUE EXTREMES ARE 0.000 32.911

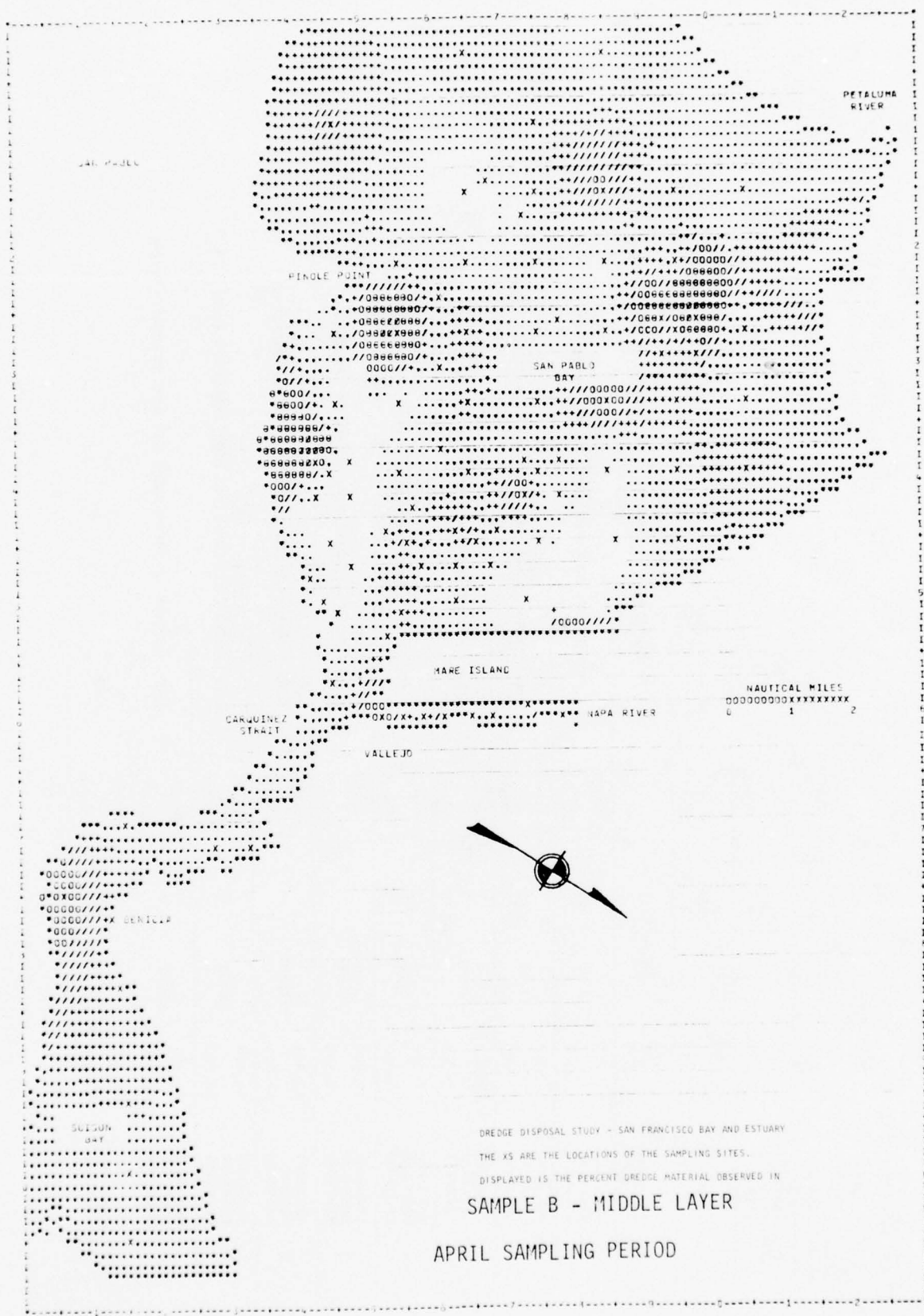
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLL LLLLLLL	0.000 0.000		0	0.00 0.00	0.00
1		0.000 0.000	0.50 0.50	27	3.00 50.94	50.94 ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2		0.500 2.000	1.50 1.50	6	50.94 62.26	11.32 ONE HALF TO TWO PER CENT DREDGE MATERIAL
3		2.000 4.000	2.00 2.00	6	62.26 73.58	11.32 TWO TO FOUR PER CENT DREDGE MATERIAL
4		4.000 6.000	2.00 2.00	5	73.58 83.02	9.43 FOUR TO SIX PER CENT DREDGE MATERIAL
5		6.000 8.000	2.00 2.00	5	83.02 92.45	9.43 SIX TO EIGHT PER CENT DREDGE MATERIAL
6		8.000 10.000	2.00 2.00	0	92.45 92.45	0.00 EIGHT TO TEN PER CENT DREDGE MATERIAL
7		10.000 20.000	10.00 10.00	2	92.45 96.23	3.77 TEN TO TWENTY PER CENT DREDGE MATERIAL
8		20.000 40.000	20.00 20.00	2	96.23 100.00	3.77 TWENTY TO FORTY PER CENT DREDGE MATERIAL
9		40.000 80.000	40.00 40.00	0	100.00 100.00	0.00 FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10		80.000 100.000	20.00 20.00	0	100.00 100.00	0.00 EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHH HHHHHHH	100.000 100.000		0	100.00 100.00	0.00



SAMPLE A TOP LAYER  
APRIL SAMPLING PERIOD

DATA VALUE EXTREMES ARE 0.000 24.972

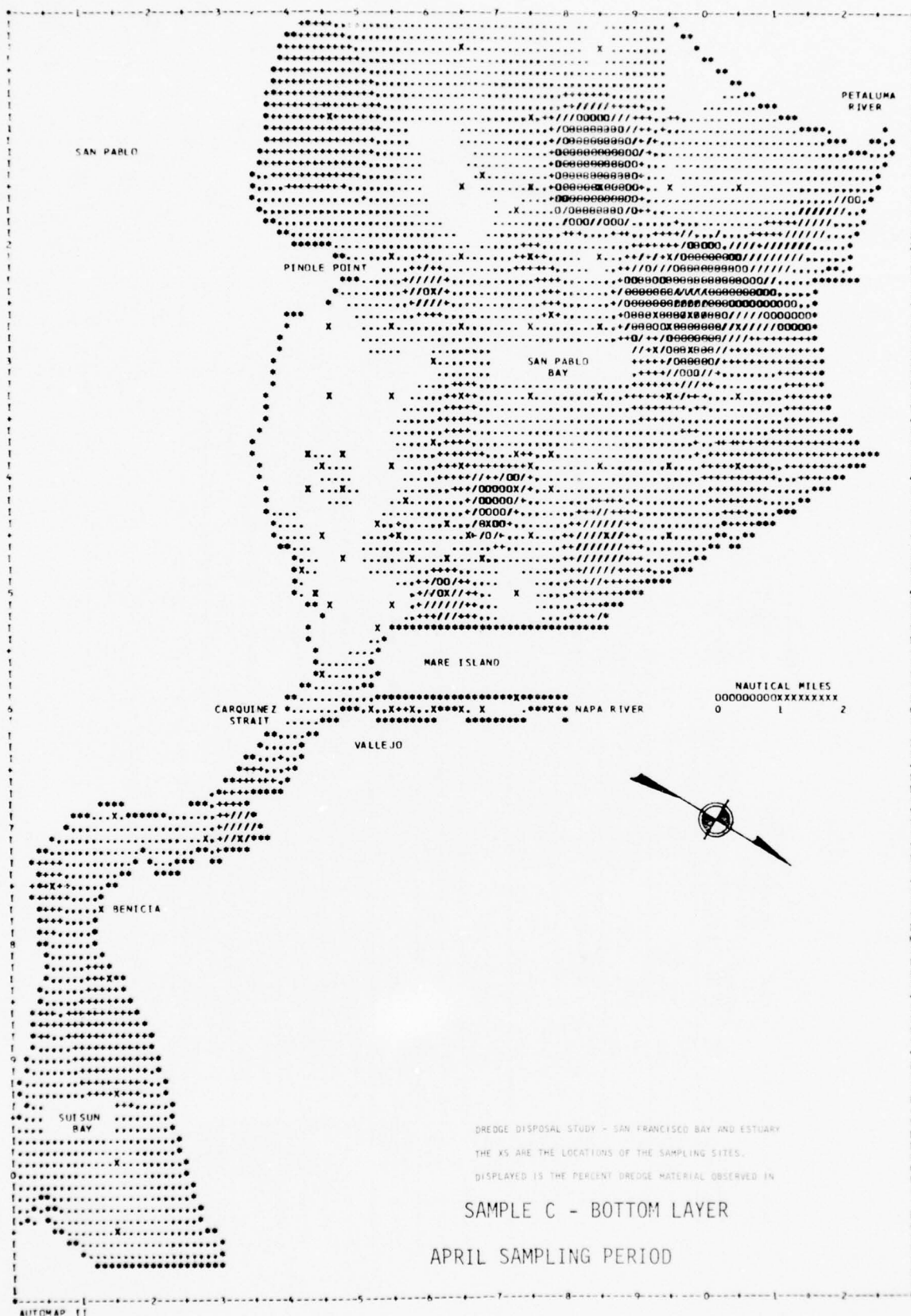
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000 0.000	0.000 0.000 0.000	0	0.00 0.00 0.00	0.00 0.00 0.00
1		0.000 .500	.50	24	0.00 26.37	26.37
2	..... ..... .....	.500 2.000	1.50	22	26.37 50.55	24.18
3	..... ..... .....	2.000 4.000	2.00	25	50.55 78.02	27.47
4	++++++ ++++++ ++++++	4.000 6.000	2.00	8	78.02 86.81	8.79
5	//////// //////// ////////	6.000 9.000	2.00	6	86.81 93.41	6.55
6	00000000 00000000 00000000	9.000 10.000	2.00	0	93.41 93.41	0.00
7	EEEEEEEE EEEEEEEE EEEEEEEE	10.000 20.000	10.00	3	93.41 96.70	3.30
8	00000000 00000000 00000000	20.000 40.000	20.00	3	96.70 100.00	3.30
9	EEEEEEEE EEEEEEEE EEEEEEEE	40.000 80.000	40.00	0	100.00 100.00	0.00
10	00000000 00000000 00000000	80.000 100.000	20.00	0	100.00 100.00	0.00
HIGH	HHHHHHHH HHHHHHHH HHHHHHHH	100.000 100.000	100.00	0	100.00 100.00	0.00



SAMPLE B MIDDLE LAYER  
APRIL SAMPLING PERIOD

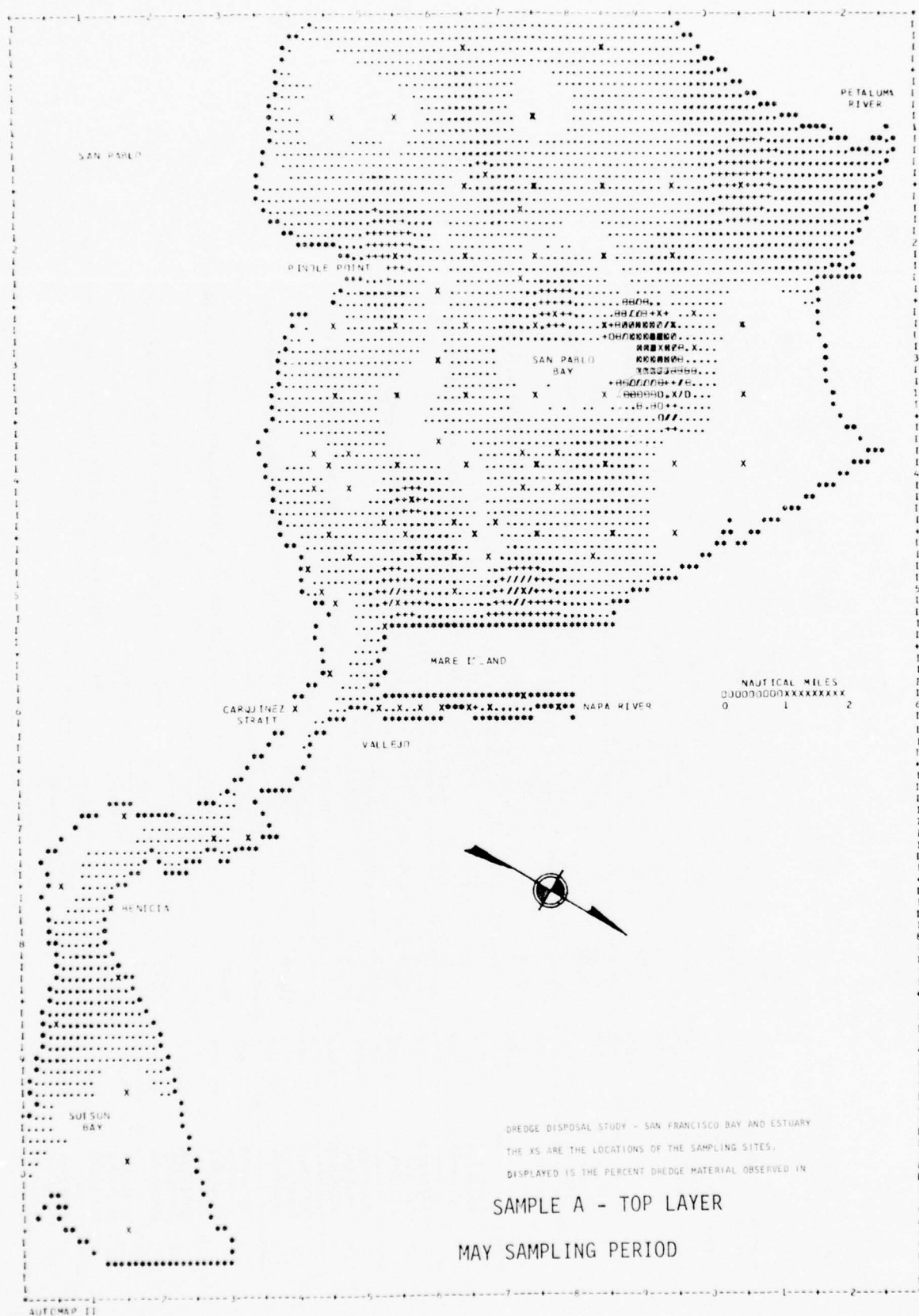
DATA VALUE EXTREMES ARE 0.000 28.890

LEVEL	SYMBOL	VALUE	PERCENT	PERCENTILE	PERCENT
NUMBER		RANGE	RANGE	RANGE	AREAS
	LLLLLLLL	0.000	0	0.00	0.00
	LLLLLLLL	0.000	0	0.00	0.00
	0.000	0.000	0	0.00	0.00
1		0.000	23	0.00	25.00
		0.000	23	0.00	25.00
2		0.000	22	0.00	25.00
		0.000	22	0.00	25.00
3		0.000	20	0.00	25.00
		0.000	20	0.00	25.00
4		0.000	11	0.00	25.00
		0.000	11	0.00	25.00
5		0.000	6	0.00	25.00
		0.000	6	0.00	25.00
6		0.000	5	0.00	25.00
		0.000	5	0.00	25.00
7		0.000	1	0.00	25.00
		0.000	1	0.00	25.00
8		0.000	4	0.00	25.00
		0.000	4	0.00	25.00
9		0.000	0	0.00	25.00
		0.000	0	0.00	25.00
10		0.000	0	0.00	25.00
		0.000	0	0.00	25.00
HIGH		0.000	0	0.00	25.00
		0.000	0	0.00	25.00



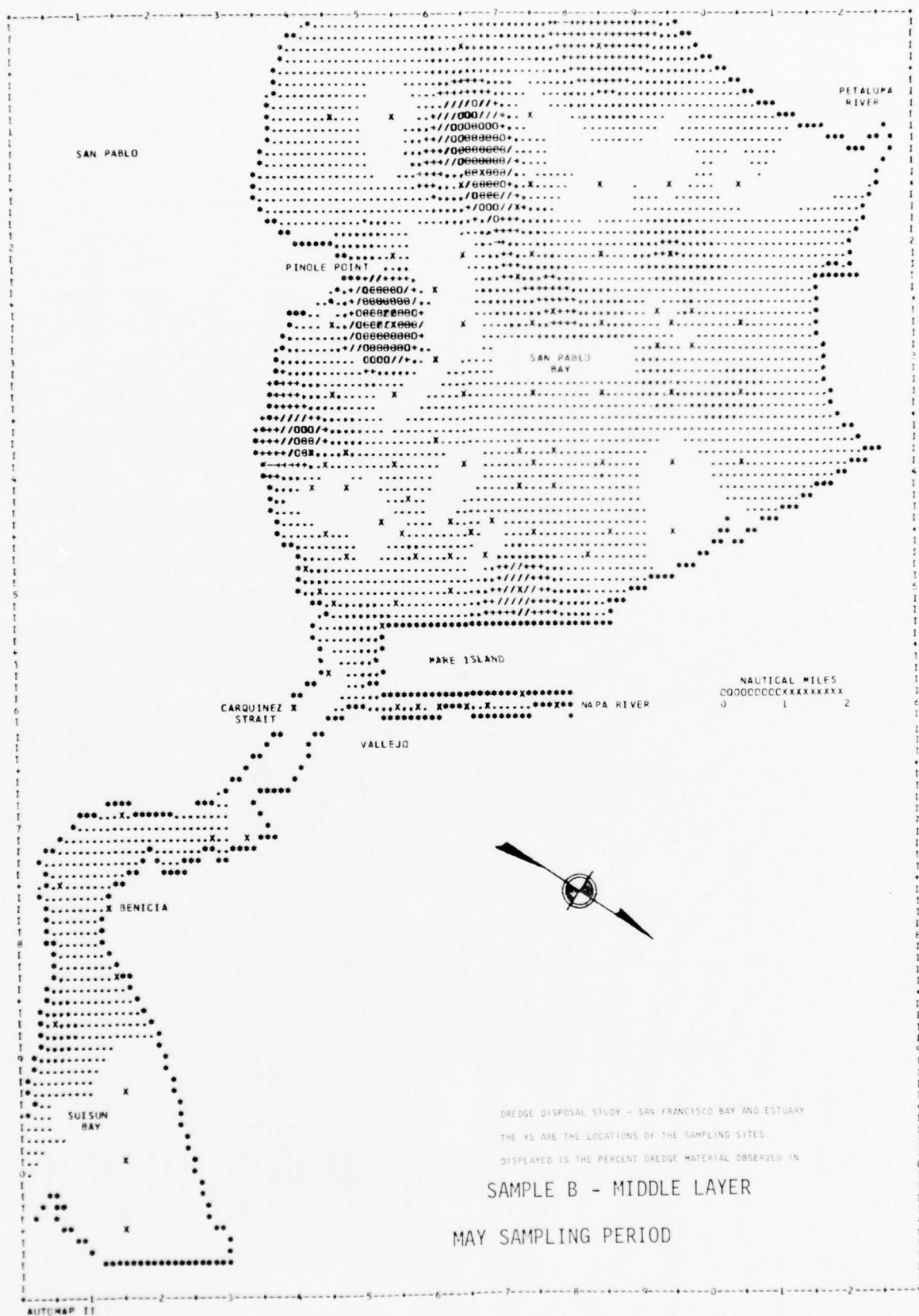
SAMPLE C - BOTTOM LAYER  
APRIL SAMPLING PERIOD

DATA VALUE EXTREMES ARE				0.000	29.017				
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS			
LOW	LLLLLLL	0.000		0	0.00	0.00			
	LLLLLLL	0.000			0.00	0.00			
1		0.000		27	0.00	29.67	ZERO TO ONE HALF PER CENT DREDGE MATERIAL		
		.500			29.67				
2		.500		24	29.67	26.37	ONE HALF TO TWO PER CENT DREDGE MATERIAL		
		2.000			56.04				
3		2.000		13	56.04	14.29	TWO TO FOUR PER CENT DREDGE MATERIAL		
		4.000			70.33				
4		4.000		14	70.33	15.38	FOUR TO SIX PER CENT DREDGE MATERIAL		
		6.000			85.71				
5		6.000		4	85.71	4.40	SIX TO EIGHT PER CENT DREDGE MATERIAL		
		8.000			90.11				
6		8.000		4	90.11	4.40	EIGHT TO TEN PER CENT DREDGE MATERIAL		
		10.000			94.51				
7		10.000		4	94.51	4.40	TEN TO TWENTY PER CENT DREDGE MATERIAL		
		20.000			98.90				
8		20.000		1	98.90	1.10	TWENTY TO FORTY PER CENT DREDGE MATERIAL		
		40.000			100.00				
9		40.000		0	100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL		
		80.000			100.00				
10		80.000		0	100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL		
		100.000			100.00				
HIGH		100.000		0	100.00	0.00			
		100.000			100.00				



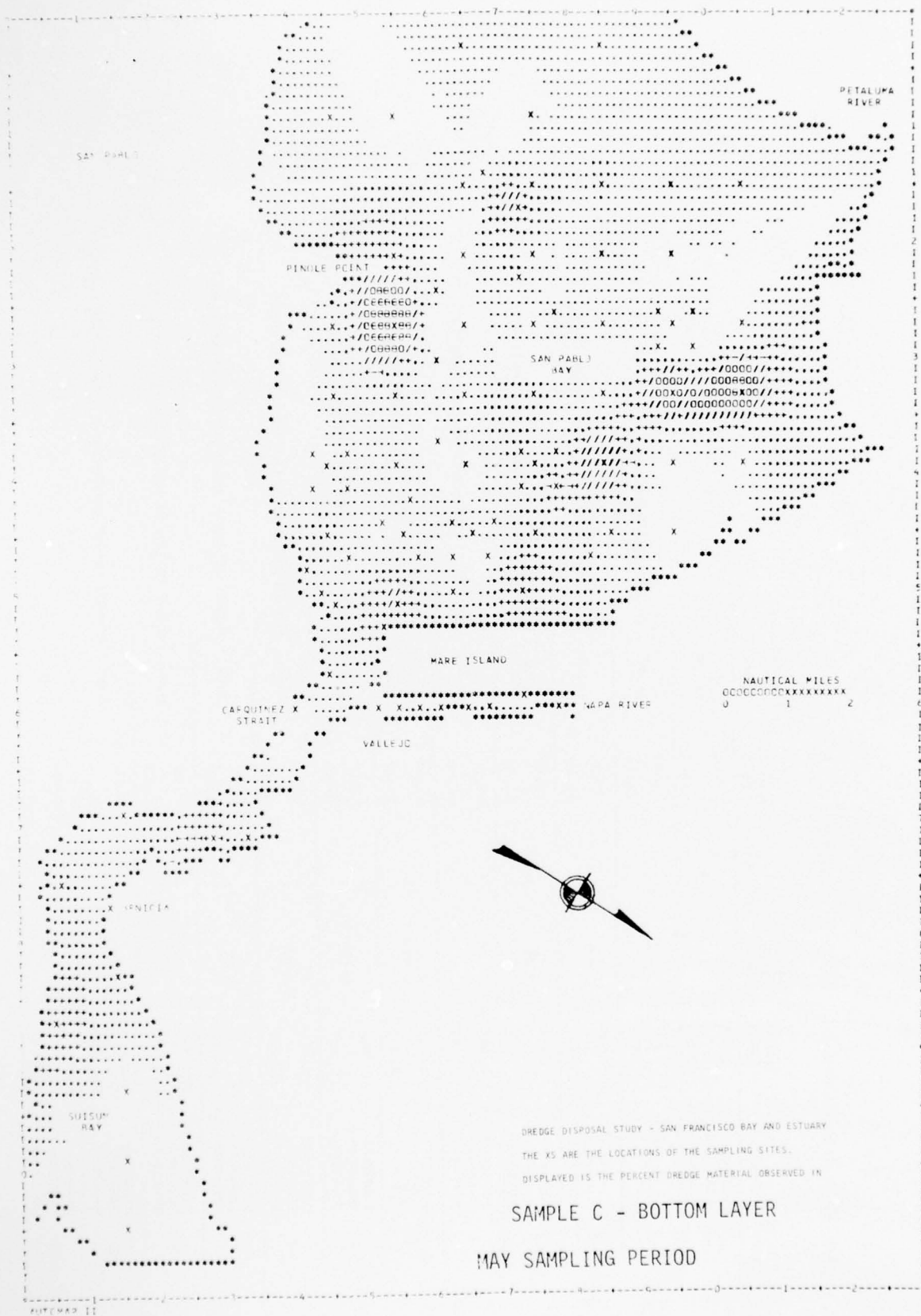
SAMPLE A - TOP LAYER  
MAY SAMPLING PERIOD

DATA VALUE EXTREMES ARE		0.000	99.000		
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000 0.000	0	0.00 0.00 0.00	0.00 0.00 0.00
1		0.000 .500 .500	41	0.00 42.27 42.27	0.00 42.27 42.27
2	..... ..... .....	.500 1.500 2.000	35	42.27 78.35 78.35	42.27 36.08 36.08
3	..... ..... .....	2.000 2.000 4.000	12	78.35 90.72 90.72	12.37 12.37 12.37
4	++++++ ++++++ ++++++	4.000 5.000 5.000	4	90.72 94.85 94.85	4.12 4.12 4.12
5	//////// //////// ////////	6.000 8.000 8.000	3	94.85 97.94 97.94	3.09 3.09 3.09
6	00000000 00000000 00000000	9.000 10.000 10.000	1	97.94 98.97 98.97	1.03 1.03 1.03
7	88888888 88888888 88888888	10.000 20.000 20.000	0	98.97 98.97 98.97	0.00 0.00 0.00
8	66666666 66666666 66666666	20.000 40.000 40.000	0	98.97 98.97 98.97	0.00 0.00 0.00
9	33333333 33333333 33333333	40.000 60.000 80.000	0	98.97 98.97 98.97	0.00 0.00 0.00
10	11111111 11111111 11111111	80.000 100.000 100.000	1	98.97 100.00 100.00	1.03 1.03 1.03
HIGH	HHHHHHHH HHHHHHHH HHHHHHHH	100.000 100.000 100.000	0	100.00 100.00 100.00	0.00 0.00 0.00



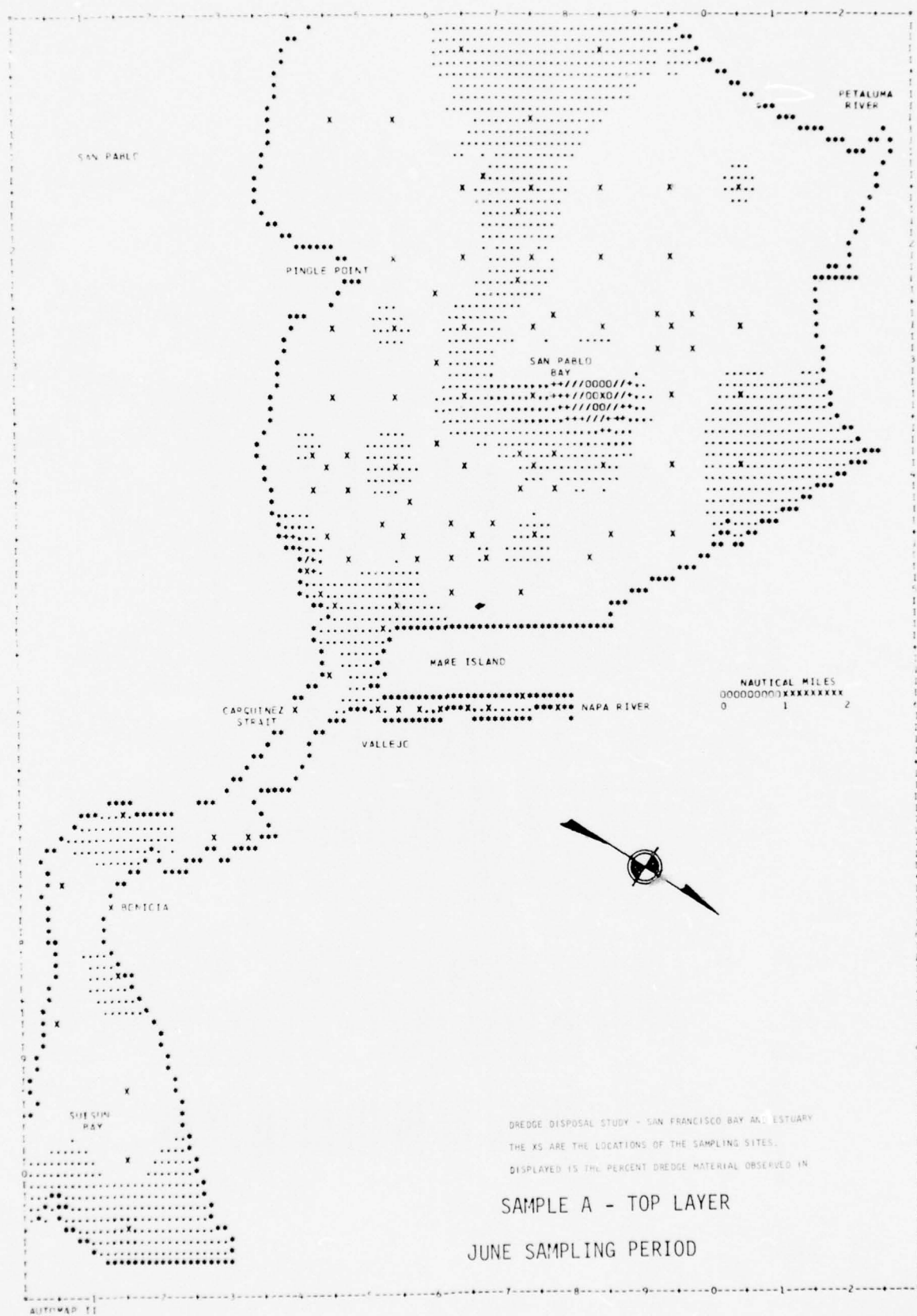
SAMPLE 8 - MIDDLE LAYER  
MAY SAMPLING PERIOD

DATA VALUE EXTREMES ARE				0.000	21.805		
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL	0.000		0	0.00	0.00	
	LLLLLLLL	0.000			0.00		
	LLLLLLLL	0.000			0.00		
1		0.000	.500	35	0.00	36.46	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
		.500			26.46		
2	.....	.500	1.500	33	26.46	34.38	ONE HALF TO TWO PER CENT DREDGE MATERIAL
	.....	2.000			70.83		
3	.....	2.000	2.000	18	70.83	18.75	TWO TO FOUR PER CENT DREDGE MATERIAL
	.....	4.000			89.58		
4	.....	4.000	2.000	5	89.58	5.21	FOUR TO SIX PER CENT DREDGE MATERIAL
	.....	6.000			94.79		
5	////////	6.000	2.000	1	94.79	1.04	SIX TO EIGHT PER CENT DREDGE MATERIAL
	////////	8.000			95.83		
6	00000000	8.000	2.000	1	95.83	1.04	EIGHT TO TEN PER CENT DREDGE MATERIAL
	00000000	10.000			96.87		
7	88888888	10.000	10.000	1	96.87	1.04	TEN TO TWENTY PER CENT DREDGE MATERIAL
	88888888	20.000			97.92		
8	88888888	20.000	20.000	2	97.92	2.08	TWENTY TO FORTY PER CENT DREDGE MATERIAL
	88888888	40.000			100.00		
9	88888888	40.000	40.000	0	100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
	88888888	80.000			100.00		
10	88888888	80.000	20.000	0	100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
	88888888	100.000			100.00		
HIGH	HHHHHHHH	100.000		0	100.00	0.00	
	HHHHHHHH	100.000			100.00		



SAMPLE C. BOTTOM LAYER  
MAY SAMPLING PERIOD

DATA VALUE EXTREMES ARE			0.000	15.451	
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE
LOW	LLLLLLL	0.000		0	0.00
	LLLLLLL	0.000			0.00
1		0.000	.500	30	30.53
		.500			30.53
2		.500	1.500	40	30.53
		2.000			72.16
3		2.000	2.000	15	72.16
		4.000			87.63
4		4.000	2.000	6	87.63
		6.000			93.81
5		6.000	2.000	1	93.81
		8.000			94.85
6		8.000	2.000	3	94.85
		10.000			97.54
7		10.000	13.000	2	97.54
		20.000			100.00
8		20.000	20.000	0	100.00
		40.000			100.00
9		40.000	43.000	0	100.00
		80.000			100.00
10		80.000	23.000	0	100.00
		100.000			100.00
HIGH	HHHHHHH	100.000		0	100.00
	HHHHHHH	100.000			100.00



SAMPLE 1 - TOP LAYER  
JUNE SAMPLING PERIOD

DATA VALUE EXTREMES ARE			0.000	9.005			
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000 0.000		0	0.00 0.00 0.00	0.00	
1		0.000 .500		64	0.00 65.98	65.98	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2	..... ..... .....	.500 2.030	1.50	24	65.98 90.72	24.74	ONE HALF TO TWO PER CENT DREDGE MATERIAL
3	..... ..... .....	2.000 4.000	2.00	6	90.72 96.91	6.19	TWO TO FOUR PER CENT DREDGE MATERIAL
4	++++++ ++++++ ++++++	4.000 5.000	2.00	1	96.91 97.54	1.03	FOUR TO SIX PER CENT DREDGE MATERIAL
5	//////// //////// ////////	6.000 8.000	2.00	1	97.54 98.97	1.03	SIX TO EIGHT PER CENT DREDGE MATERIAL
6	00000000 00000000 00000000	8.000 10.000	2.00	1	98.97 100.00	1.03	EIGHT TO TEN PER CENT DREDGE MATERIAL
7	88888888 88888888 88888888	10.000 20.000	10.00	0	100.00 100.00	0.00	TEN TO TWENTY PER CENT DREDGE MATERIAL
8	00000000 00000000 00000000	20.000 40.000	20.00	0	100.00 100.00	0.00	TWENTY TO FORTY PER CENT DREDGE MATERIAL
9	88888888 88888888 88888888	40.000 80.000	40.00	0	100.00 100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10	00000000 00000000 00000000	80.000 100.000	20.00	0	100.00 100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHHH HHHHHHHH HHHHHHHH	100.000 100.000		0	100.00 100.00	0.00	



SAMPLE B - MIDDLE LAYER

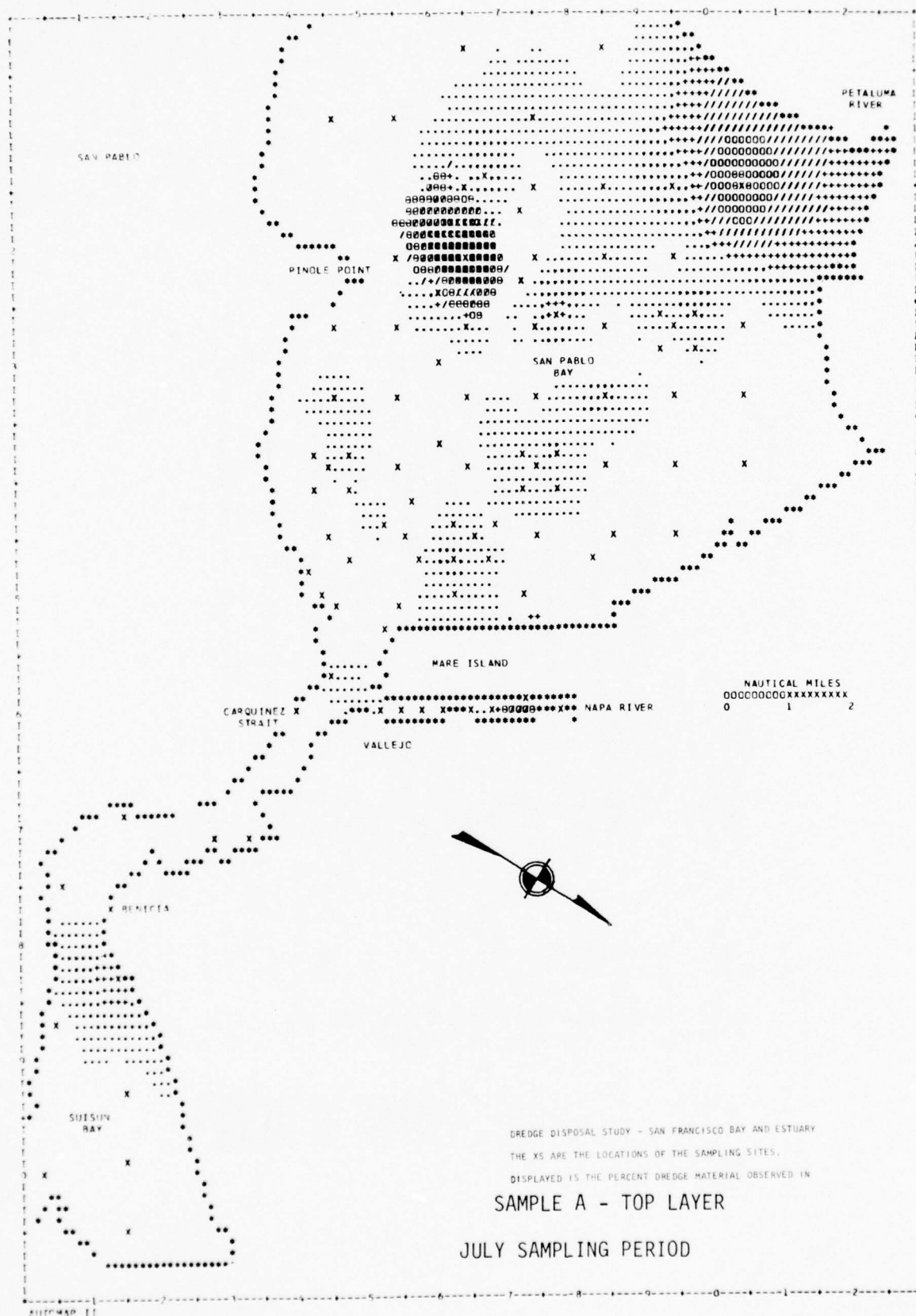
JUNE SAMPLING PERIOD

DATA VALUE EXTREMES ARE		0.000	4.574		
LEVEL NUMBER	SAMPLE SYMBOL	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLLL	0.000	0	0.00	0.00
	LLLLLLLL	0.000		0.00	
	LLLLLLLL	0.000		0.00	
1		0.000		0.00	
		.500	64	65.58	65.98
ZERO TO ONE HALF PER CENT DREDGE MATERIAL					
2		.500		65.58	
		2.000	24	90.72	24.74
ONE HALF TO TWO PER CENT DREDGE MATERIAL					
3		2.000		90.72	
		4.000	6	96.91	6.19
TWO TO FOUR PER CENT DREDGE MATERIAL					
4		4.000		96.91	
		6.000	3	100.00	3.09
FOUR TO SIX PER CENT DREDGE MATERIAL					
5		6.000		100.00	
		8.000	0	100.00	0.00
SIX TO EIGHT PER CENT DREDGE MATERIAL					
6		8.000		100.00	
		10.000	0	100.00	0.00
EIGHT TO TEN PER CENT DREDGE MATERIAL					
7		10.000		100.00	
		20.000	0	100.00	0.00
TEN TO TWENTY PER CENT DREDGE MATERIAL					
8		20.000		100.00	
		40.000	0	100.00	0.00
TWENTY TO FORTY PER CENT DREDGE MATERIAL					
9		40.000		100.00	
		80.000	0	100.00	0.00
FORTY TO EIGHTY PER CENT DREDGE MATERIAL					
10		80.000		100.00	
		100.000	0	100.00	0.00
EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL					
HIGH		100.000		100.00	
		100.000	0	100.00	0.00



DATA VALUE	EXTREMES ARE	0.000	15.757
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LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
1	LLLLLLL	0-300	0-300	0	0-00	0-00
	LLLLLLL	0-600	0-600		0-00	
	LLLLLLL	0-300	0-300		0-00	
1		0-300	0-300	61	0-00	62-89
		0-500	0-500		62-89	
2	.....	0-500	0-500	23	62-89	23-71
	.....	2-000	1-500		86-60	
3	.....	2-300	2-000	7	86-60	7-22
	.....	4-000	3-81		93-81	
4	.....	4-300	2-000	3	93-81	3-69
	.....	6-000	2-000		96-91	
5	////////	6-000	2-000	0	96-91	0-00
	////////	8-000	2-000	1	96-91	1-03
	00000000	8-000	2-000		97-94	
	00000000	10-000	13-000	2	100-00	2-06
	00000000	10-000	13-000		100-00	
7	00000000	20-000	20-000	0	100-00	0-00
	00000000	20-000	20-000		100-00	
8	00000000	40-000	40-000	0	100-00	0-00
	00000000	40-000	40-000		100-00	
9	00000000	60-000	60-000	0	100-00	0-00
	00000000	60-000	60-000		100-00	
10	00000000	80-000	80-000	0	100-00	0-00
	00000000	100-000	23-000		100-00	
11	00000000	100-000	100-000	0	100-00	0-00
	00000000	100-000	100-000		100-00	



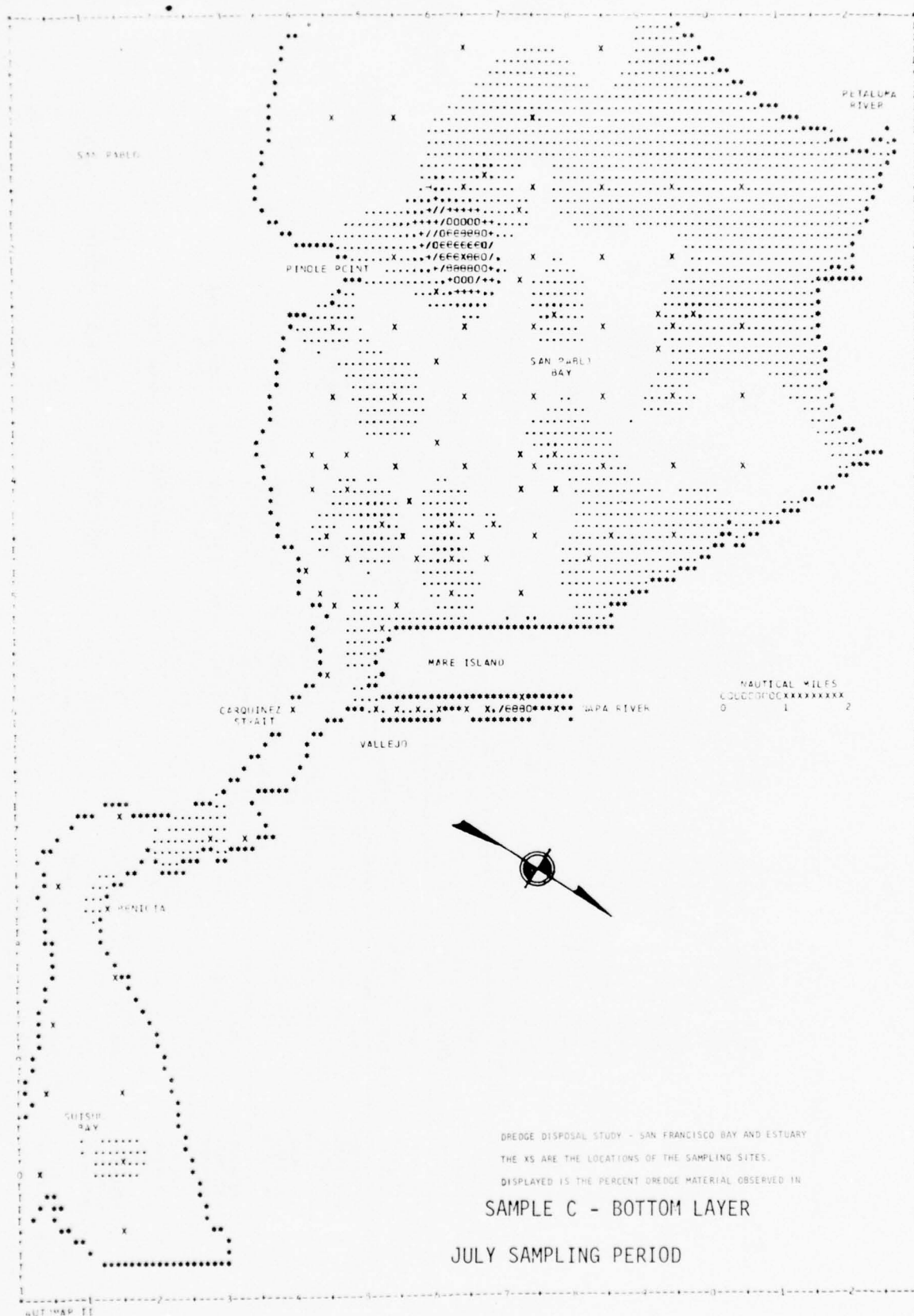
SAMPLE 4 - TOP LAYER  
JULY SAMPLING PERIOD

DATA VALUE EXTREMES ARE				0.000	98.935		
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL	0.000		0	0.00	0.00	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
	LLLLLLLL	0.000			0.00		
	LLLLLLLL	0.000			0.00		
1		0.000	.500	65	0.00	66.33	ONE HALF TO TWO PER CENT DREDGE MATERIAL
		.500			66.33		
2		.500	1.500	21	66.33	21.43	TWO TO FOUR PER CENT DREDGE MATERIAL
		2.000			87.76		
3		2.000	2.000	6	87.76	6.12	FOUR TO SIX PER CENT DREDGE MATERIAL
		4.000			93.88		
4		4.000	2.000	3	93.88	3.06	SIX TO EIGHT PER CENT DREDGE MATERIAL
		6.000			96.94		
5		6.000	2.000	0	96.94	0.00	EIGHT TO TEN PER CENT DREDGE MATERIAL
		8.000			96.94		
6		8.000	2.000	0	96.94	0.00	TEN TO TWENTY PER CENT DREDGE MATERIAL
		10.000			96.94		
7		10.000	10.000	1	96.94	1.02	TWENTY TO FORTY PER CENT DREDGE MATERIAL
		20.000			97.96		
8		20.000	20.000	1	97.96	1.02	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
		40.000			98.98		
9		40.000	40.000	0	98.98	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
		80.000			98.98		
10		80.000	20.000	1	98.98	1.02	
		100.000			100.00		
HIGH		100.000		0	100.00	0.00	
		100.000			100.00		



SAMPLE 8 - MIDDLE LAYER  
JULY SAMPLING PERIOD

DATA VALUE EXTREMES ARE		0.000	25.143			
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLLL	0.000		0	0.00	0.00
	LLLLLLLL	0.000			0.00	
	LLLLLLLL	0.000			0.00	
1		0.000	.50	64	0.00	64.65
		.500			64.65	
2		.500	1.50	23	64.65	23.23
		2.000			87.88	
3		2.000	2.00	8	87.88	8.08
		4.000			95.96	
4		4.000	2.00	1	95.96	1.01
		6.000			96.57	
5		6.000	2.00	1	96.57	1.01
		8.000			97.98	
6		8.000	2.00	1	97.98	1.01
		10.000			98.59	
7		10.000	10.00	0	98.59	0.00
		20.000			98.99	
8		20.000	20.00	1	98.99	1.01
		40.000			100.00	
9		40.000	40.00	0	100.00	0.00
		80.000			100.00	
10		80.000	20.00	0	100.00	0.00
		100.000			100.00	
HIGH		100.000		0	100.00	0.00
		100.000			100.00	



SAMPLE C BOTTOM LAYER  
JULY SAMPLING PERIOD

DATA VALUE EXTREMES ARE			0.000	14.717			
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLL LLLLLLL	0.000 0.000	0.000 0.000	0	0.00 0.00	0.00	
1		0.000 -500	0.00 -50	62	0.00 63.27	63.27	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2		0.000 -500 2.000	0.00 -50 1.53	26	63.27 69.80	26.53	ONE HALF TO TWO PER CENT DREDGE MATERIAL
3		0.000 2.000 4.000	0.00 2.00 4.00	8	69.80 87.56	8.16	TWO TO FOUR PER CENT DREDGE MATERIAL
4		0.000 4.000 6.000	0.00 2.00 2.00	0	87.56 87.96	0.00	FOUR TO SIX PER CENT DREDGE MATERIAL
5		0.000 6.000 8.000	0.00 2.00 2.00	0	87.96 87.96	0.00	SIX TO EIGHT PER CENT DREDGE MATERIAL
6		0.000 8.000 10.000	0.00 2.00 2.00	0	87.96 97.96	0.00	EIGHT TO TEN PER CENT DREDGE MATERIAL
7		0.000 10.000 20.000	0.00 10.00 10.00	2	97.96 100.00	2.04	TEN TO TWENTY PER CENT DREDGE MATERIAL
8		0.000 20.000 40.000	0.00 20.00 20.00	0	100.00 100.00	0.00	TWENTY TO FORTY PER CENT DREDGE MATERIAL
9		0.000 40.000 80.000	0.00 40.00 40.00	0	100.00 100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10		0.000 80.000 100.000	0.00 20.00 20.00	0	100.00 100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHH HHHHHHH	100.000 100.000	100.00 100.00	0	100.00 100.00	0.00	



SAMPLE A - TOP LAYER  
AUGUST SAMPLING PERIOD

DATA VALUE EXTREMES ARE		0.000	5.142	
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	PERCENTILE RANGE
LOW	LLLLLLL LLLLLLL LLLLLLL	0.000 0.000	0	0.00
1		0.000 .500	.50 78	0.00 78.79
2	..... ..... .....	.500 2.000	1.50 15	78.79 93.94
3	..... ..... .....	2.000 4.000	2.00 5	93.94 98.99
4	+++++++ +++++++ +++++++	4.000 6.000	2.00 1	98.99 100.00
5	///////// ///////// /////////	6.000 8.000	2.00 0	100.00 100.00
6	00000000 00000000 00000000	8.000 10.000	2.00 0	100.00 100.00
7	8888888 8888888 8888888	10.000 20.000	10.00 0	100.00 100.00
8	00000000 00000000 00000000	20.000 40.000	20.00 0	100.00 100.00
9	8888888 8888888 8888888	40.000 80.000	40.00 0	100.00 100.00
10	8888888 8888888 8888888	80.000 100.000	20.00 0	100.00 100.00
HIGH	HHHHHHH HHHHHHH HHHHHHH	100.000 100.000	0 0	100.00 100.00

ZERO TO ONE HALF PER CENT DREDGE MATERIAL

ONE HALF TO TWO PER CENT DREDGE MATERIAL

TWO TO FOUR PER CENT DREDGE MATERIAL

FOUR TO SIX PER CENT DREDGE MATERIAL

SIX TO EIGHT PER CENT DREDGE MATERIAL

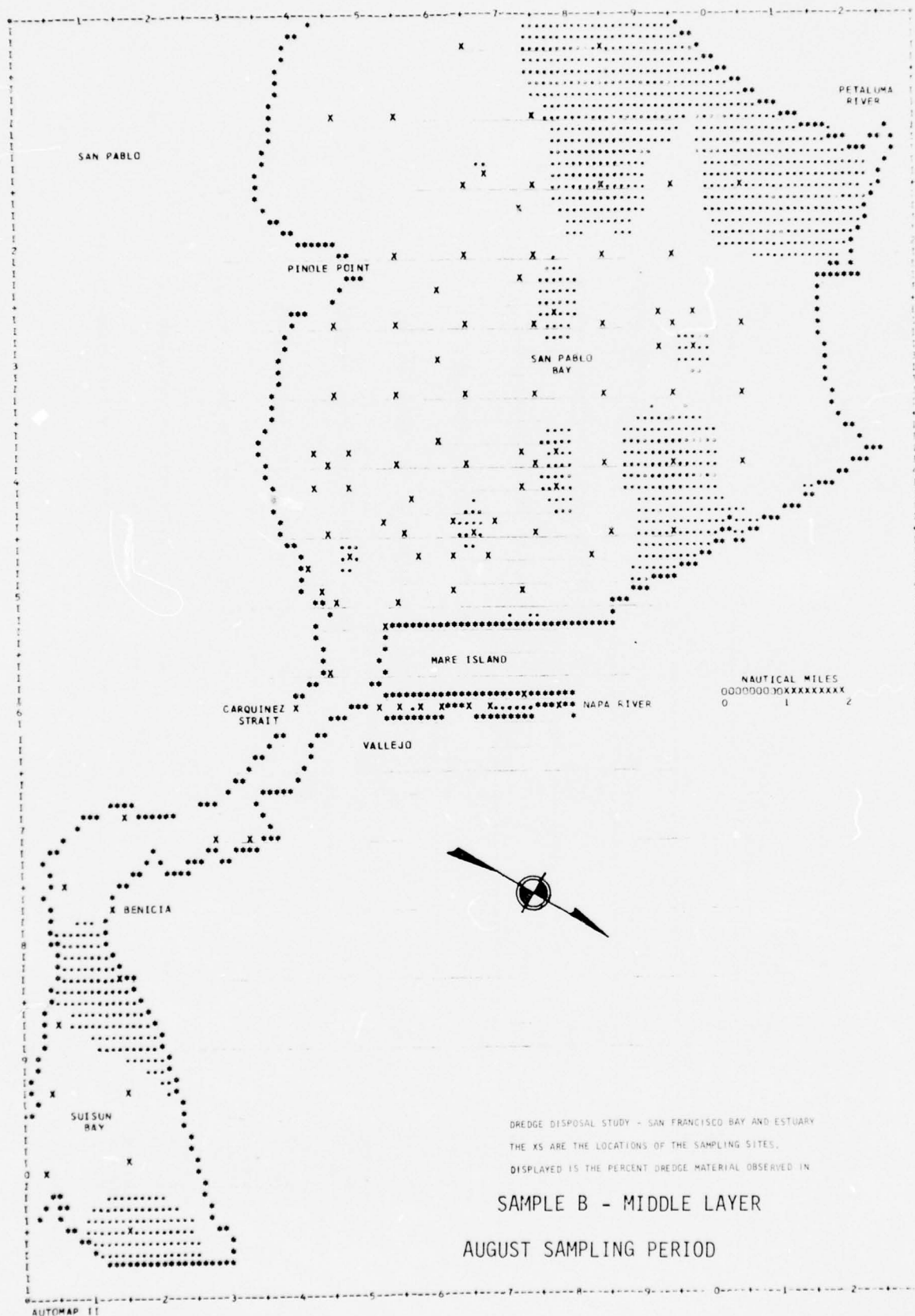
EIGHT TO TEN PER CENT DREDGE MATERIAL

TEN TO TWENTY PER CENT DREDGE MATERIAL

TWENTY TO FORTY PER CENT DREDGE MATERIAL

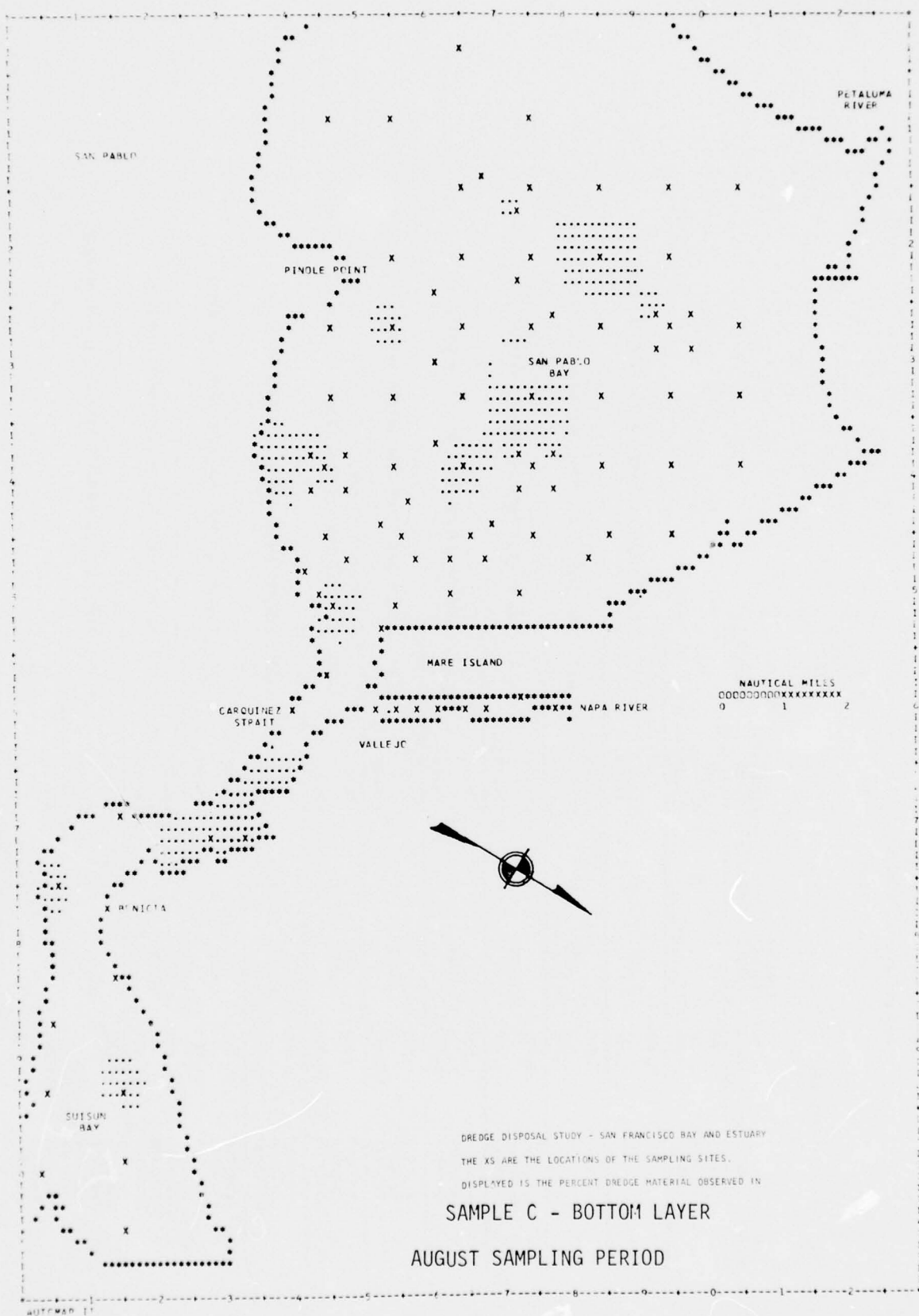
FORTY TO EIGHTY PER CENT DREDGE MATERIAL

EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL



SAMPLE B - MIDDLE LAYER  
AUGUST SAMPLING PERIOD

DATA VALUE EXTREMES ARE						0.000	3.870
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL	0.000		0	0.00	0.00	
	LLLLLLLL	0.000			0.00		
	LLLLLLLL	0.000			0.00		
1		0.000	.50	82	82.83	82.83	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2	.....	.500			82.83		
	.....	2.000	1.50	13	95.96	13.13	ONE HALF TO TWO PER CENT DREDGE MATERIAL
	.....	2.000			95.96		
3	.....	2.000		4	100.00	4.04	TWO TO FOUR PER CENT DREDGE MATERIAL
	.....	4.000	2.00		100.00		
	.....	4.000			100.00		
4	++++++	4.000		0	100.00	0.00	FOUR TO SIX PER CENT DREDGE MATERIAL
	++++++	6.000	2.00		100.00		
	++++++	6.000			100.00		
5	////////	6.000		0	100.00	0.00	SIX TO EIGHT PER CENT DREDGE MATERIAL
	////////	8.000	2.00		100.00		
	////////	8.000			100.00		
6	00000000	8.000		0	100.00	0.00	EIGHT TO TEN PER CENT DREDGE MATERIAL
	00000000	10.000	2.00		100.00		
	00000000	10.000			100.00		
7	88888888	10.000		0	100.00	0.00	TEN TO TWENTY PER CENT DREDGE MATERIAL
	88888888	20.000	10.00		100.00		
	88888888	20.000			100.00		
8	22222222	20.000		0	100.00	0.00	TWENTY TO FORTY PER CENT DREDGE MATERIAL
	22222222	40.000	20.00		100.00		
	22222222	40.000			100.00		
9	88888888	40.000		0	100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
	88888888	80.000	40.00		100.00		
	88888888	80.000			100.00		
10	88888888	80.000		0	100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
	88888888	100.000	20.00		100.00		
	88888888	100.000			100.00		
HIGH	HHHHHHHH	100.000		0	100.00	0.00	
	HHHHHHHH	100.000			100.00		
	HHHHHHHH	100.000			100.00		

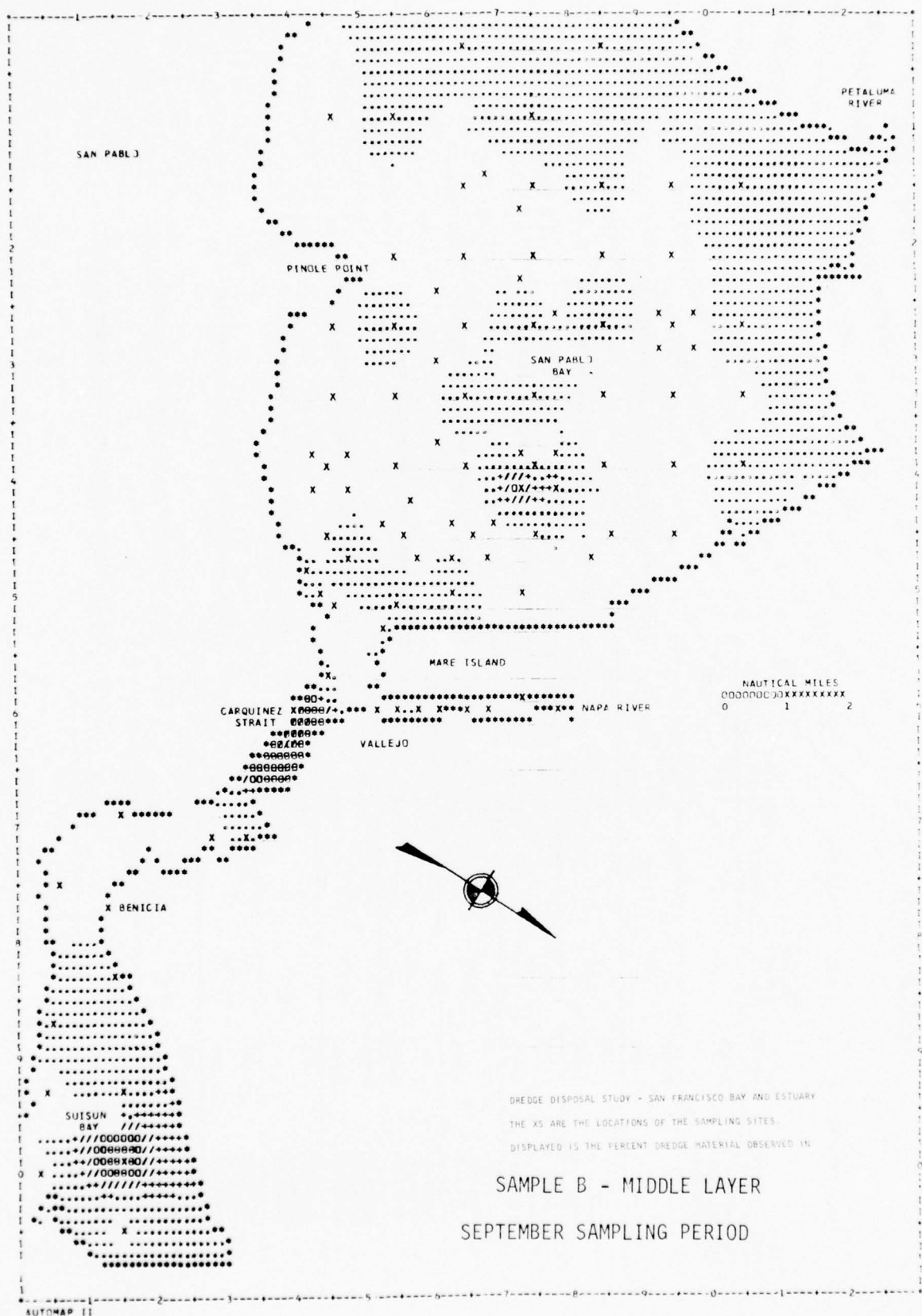


SAMPLE C BOTTOM LAYER  
AUGUST SAMPLING PERIOD

DATA VALUE EXTREMES ARE			0.000	3.500			
LEVEL	PERCENT	VALUE	PERCENT	PERCENTILE	PERCENT	PERCENT	PERCENT
NUMBER	OF	RANGE	RANGE	RANGE	RANGE	RANGE	RANGE
1	0.000	0.000	0.000	0.00	0.00	0.00	0.00
2	0.000	0.000	0.000	0.00	0.00	0.00	0.00
3	0.000	0.000	0.000	0.00	0.00	0.00	0.00
4	0.000	0.000	0.000	0.00	0.00	0.00	0.00
5	0.000	0.000	0.000	0.00	0.00	0.00	0.00
6	0.000	0.000	0.000	0.00	0.00	0.00	0.00
7	0.000	0.000	0.000	0.00	0.00	0.00	0.00
8	0.000	0.000	0.000	0.00	0.00	0.00	0.00
9	0.000	0.000	0.000	0.00	0.00	0.00	0.00
10	0.000	0.000	0.000	0.00	0.00	0.00	0.00
HIGH	0.000	0.000	0.000	0.00	0.00	0.00	0.00



DATA VALUE EXTREMES ARE				23.723		0.000	
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000 0.000		0	0.00 0.00	0.00	
1		0.000 .500	.50	73	0.00 74.49	74.49	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2		.500 2.000	1.50	19	74.49 93.88	19.39	ONE HALF TO TWO PER CENT DREDGE MATERIAL
3		2.000 4.000	2.00	4	93.88 97.96	4.08	TWO TO FOUR PER CENT DREDGE MATERIAL
4		4.000 6.000	2.00	0	97.96 97.96	0.00	FOUR TO SIX PER CENT DREDGE MATERIAL
5		6.000 8.000	2.00	0	97.96 97.96	0.00	SIX TO EIGHT PER CENT DREDGE MATERIAL
6		8.000 10.000	2.00	0	97.96 97.96	0.00	EIGHT TO TEN PER CENT DREDGE MATERIAL
7		10.000 20.000	10.00	0	97.96 97.96	0.00	TEN TO TWENTY PER CENT DREDGE MATERIAL
8		20.000 40.000	20.00	2	97.96 100.00	2.04	TWENTY TO FORTY PER CENT DREDGE MATERIAL
9		40.000 80.000	40.00	0	100.00 100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10		80.000 100.000	20.00	0	100.00 100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHHH HHHHHHHH HHHHHHHH	100.000 100.000 100.000		0	100.00 100.00	0.00	



SAMPLE R - MIDDLE LAYER  
SEPTEMBER SAMPLING PERIOD

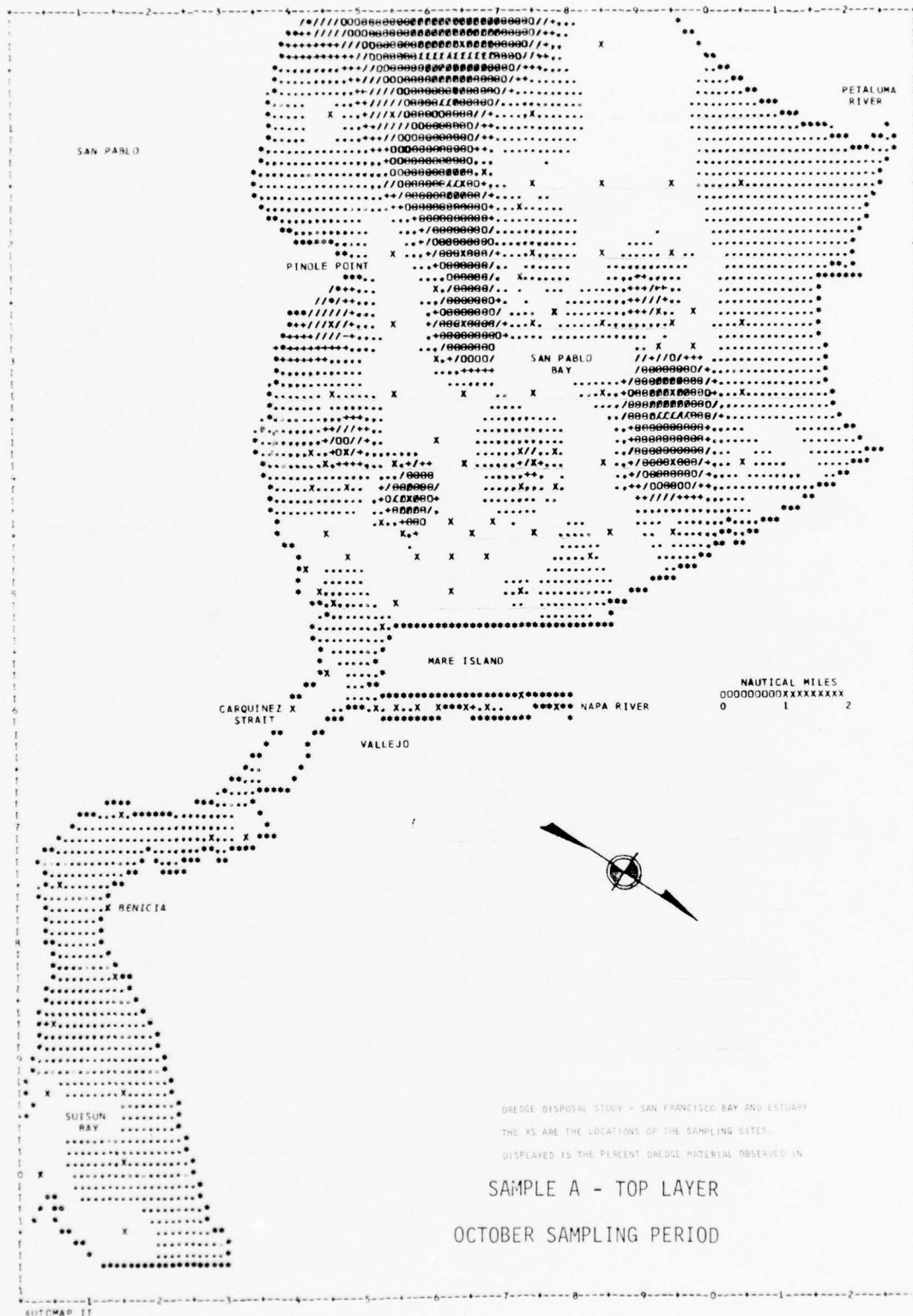
DATA VALUE EXTREMES ARE						0.000	26.491		
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS			
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000 0.000	0.00 0.00 0.00	0	0.00 0.00 0.00	0.00			
1		0.000 .500	.50 71.72	71	0.00 71.72	71.72	ZERO TO ONE HALF PER CENT DREDGE MATERIAL		
2		.500 2.000	1.50 88.89	17	71.72 88.89	17.17	ONE HALF TO TWO PER CENT DREDGE MATERIAL		
3		2.000 4.000	2.00 95.96	7	88.89 95.96	7.07	TWO TO FOUR PER CENT DREDGE MATERIAL		
4		4.000 6.000	2.00 96.97	1	95.96 96.97	1.01	FOUR TO SIX PER CENT DREDGE MATERIAL		
5		6.000 8.000	2.00 96.97	0	96.97 96.97	0.00	SIX TO EIGHT PER CENT DREDGE MATERIAL		
6		8.000 10.000	2.00 97.98	1	96.97 97.98	1.01	EIGHT TO TEN PER CENT DREDGE MATERIAL		
7		10.000 20.000	10.00 98.99	1	97.98 98.99	1.01	TEN TO TWENTY PER CENT DREDGE MATERIAL		
8		20.000 40.000	20.00 100.00	1	98.99 100.00	1.01	TWENTY TO FORTY PER CENT DREDGE MATERIAL		
9		40.000 80.000	40.00 100.00	0	100.00 100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL		
10		80.000 100.000	20.00 100.00	0	100.00 100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL		
HIGH	HHHHHHH HHHHHHH HHHHHHH	100.000 100.000 100.000	100.00 100.00 100.00	0	100.00 100.00 100.00	0.00			



SAMPLE C - BOTTOM LAYER

SEPTEMBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE		0.000	26.747			
LEVEL	SYMBOL	VALUE	PERCENT	PERCENTILE	PERCENT	
NUMBER		RANGE	RANGE	RANGE	OF	
			FREQUENCY		AREAS	
LOW	LLLLLLLL	0.000	0	0.00	0.00	
	LLLLLLLL	0.000		0.00		
1	.....	0.000	81	0.00	82.65	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
	.....	.500		82.65		
2	.....	.500	11	82.65	11.22	ONE HALF TO TWO PER CENT DREDGE MATERIAL
	.....	2.000		93.88		
3	.....	2.000	2	93.88	2.04	TWO TO FOUR PER CENT DREDGE MATERIAL
	.....	4.000		95.92		
4	.....	4.000	0	95.92	0.00	FOUR TO SIX PER CENT DREDGE MATERIAL
	.....	6.000		95.92		
5	.....	6.000	0	95.92	0.00	SIX TO EIGHT PER CENT DREDGE MATERIAL
	.....	8.000		95.92		
6	.....	8.000	0	95.92	0.00	EIGHT TO TEN PER CENT DREDGE MATERIAL
	.....	10.000		95.92		
7	.....	10.000	2	95.92	2.04	TEN TO TWENTY PER CENT DREDGE MATERIAL
	.....	20.000		97.96		
8	.....	20.000	2	97.96	2.04	TWENTY TO FORTY PER CENT DREDGE MATERIAL
	.....	40.000		100.00		
9	.....	40.000	0	100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
	.....	80.000		100.00		
10	.....	80.000	0	100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
	.....	100.000		100.00		
HIGH	.....	100.000	0	100.00	0.00	
	.....	100.000		100.00		



SAMPLE A - TOP LAYER

OCTOBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE 0.000 28.403

LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLL LLLLLLL LLLLLLL	0.000 0.000 0.000		0	0.00 0.00	0.00	
1		0.000 .500	.50	56	0.00 56.57	56.57	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2	..... ..... .....	.500 2.000	1.50	21	56.57 77.78	21.21	ONE HALF TO TWO PER CENT DREDGE MATERIAL
3	..... ..... .....	2.000 4.000	2.00	8	77.78 85.86	8.08	TWO TO FOUR PER CENT DREDGE MATERIAL
4	+++++++ +++++++ +++++++	4.000 6.000	2.00	1	85.86 86.87	1.01	FOUR TO SIX PER CENT DREDGE MATERIAL
5	///////// ///////// /////////	6.000 8.000	2.00	2	86.87 88.89	2.02	SIX TO EIGHT PER CENT DREDGE MATERIAL
6	00000000 00000000 00000000	8.000 10.000	2.00	4	88.89 92.93	4.04	EIGHT TO TEN PER CENT DREDGE MATERIAL
7	66666666 66666666 66666666	10.000 20.000	10.00	3	92.93 95.96	3.03	TEN TO TWENTY PER CENT DREDGE MATERIAL
8	00000000 00000000 00000000	20.000 40.000	20.00	4	95.96 100.00	4.04	TWENTY TO FORTY PER CENT DREDGE MATERIAL
9	00000000 00000000 00000000	40.000 80.000	40.00	0	100.00 100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10	00000000 00000000 00000000	80.000 100.000	20.00	0	100.00 100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHH HHHHHHH HHHHHHH	100.000 100.000		0	100.00 100.00	0.00	



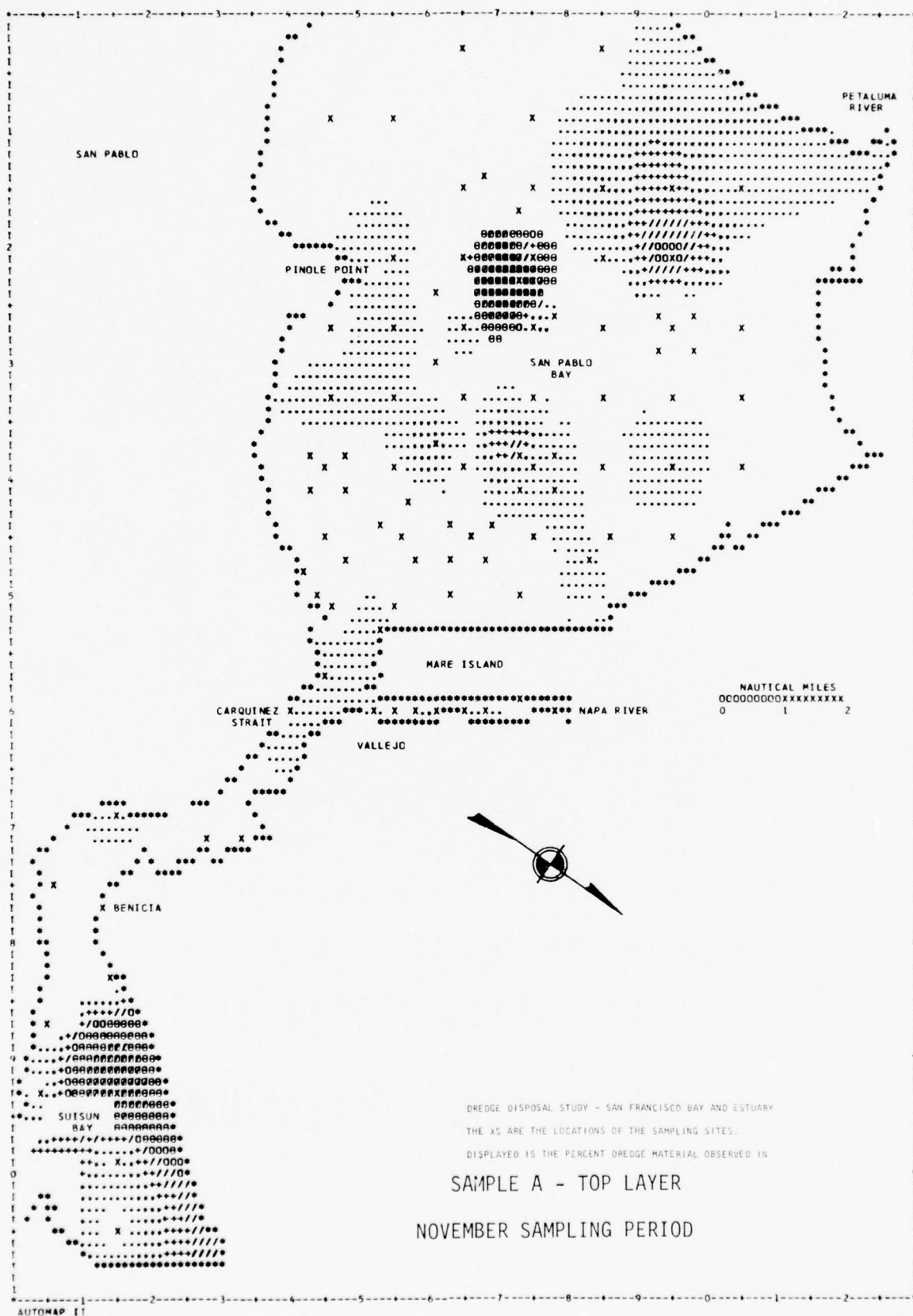
SAMPLE B - MIDDLE LAYER  
OCTOBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE 0.000 53.623

LEVEL NUMBER	SAMPLE SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS
LOW	LLLLLLLL LLLLLLLL LLLLLLLL	0.000 0.000	0.000 0.000	0	0.00 0.00	0.00
1		0.000 .500	0.000 .500	62	0.00 62.63	62.63 ZERO TO ONE HALF PER CENT DREDGE MATERIAL
2	..... ..... .....	.500 2.000	.500 2.000	14	62.63 76.77	14.14 ONE HALF TO TWO PER CENT DREDGE MATERIAL
3	..... ..... .....	2.000 4.000	2.000 4.000	6	76.77 82.83	6.06 TWO TO FOUR PER CENT DREDGE MATERIAL
4	++++++ ++++++ ++++++	4.000 6.000	4.000 6.000	4	82.83 86.87	4.04 FOUR TO SIX PER CENT DREDGE MATERIAL
5	//////// //////// ////////	6.000 8.000	6.000 8.000	3	86.87 89.90	3.03 SIX TO EIGHT PER CENT DREDGE MATERIAL
6	00000000 00000000 00000000	8.000 10.000	8.000 10.000	2	89.90 91.92	2.02 EIGHT TO TEN PER CENT DREDGE MATERIAL
7	88888888 88888888 88888888	10.000 20.000	10.000 20.000	5	91.92 96.97	5.05 TEN TO TWENTY PER CENT DREDGE MATERIAL
8	00000000 00000000 00000000	20.000 40.000	20.000 40.000	1	96.97 97.98	1.01 TWENTY TO FORTY PER CENT DREDGE MATERIAL
9	88888888 88888888 88888888	40.000 80.000	40.000 80.000	2	97.98 100.00	2.02 FORTY TO EIGHTY PER CENT DREDGE MATERIAL
10	88888888 88888888 88888888	80.000 100.000	80.000 100.000	0	100.00 100.00	0.00 EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
HIGH	HHHHHHHH HHHHHHHH HHHHHHHH	100.000 100.000	100.000 100.000	0	100.00 100.00	0.00



DATA VALUE EXTREMES ARE				0.00	49.726				
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS			
1	LLLLLLLL	1.000	0.00	0	0.00	0.00			
2	LLLLLLLL	2.000	0.00	0	0.00	0.00			
3	LLLLLLLL	3.000	0.00	0	0.00	0.00			
4	LLLLLLLL	4.000	0.00	0	0.00	0.00			
5	LLLLLLLL	5.000	0.00	0	0.00	0.00			
6	LLLLLLLL	6.000	0.00	0	0.00	0.00			
7	LLLLLLLL	7.000	0.00	0	0.00	0.00			
8	LLLLLLLL	8.000	0.00	0	0.00	0.00			
9	LLLLLLLL	9.000	0.00	0	0.00	0.00			
10	LLLLLLLL	10.000	0.00	0	0.00	0.00			
11	LLLLLLLL	11.000	0.00	0	0.00	0.00			
12	LLLLLLLL	12.000	0.00	0	0.00	0.00			
13	LLLLLLLL	13.000	0.00	0	0.00	0.00			
14	LLLLLLLL	14.000	0.00	0	0.00	0.00			
15	LLLLLLLL	15.000	0.00	0	0.00	0.00			
16	LLLLLLLL	16.000	0.00	0	0.00	0.00			
17	LLLLLLLL	17.000	0.00	0	0.00	0.00			
18	LLLLLLLL	18.000	0.00	0	0.00	0.00			
19	LLLLLLLL	19.000	0.00	0	0.00	0.00			
20	LLLLLLLL	20.000	0.00	0	0.00	0.00			
21	LLLLLLLL	21.000	0.00	0	0.00	0.00			
22	LLLLLLLL	22.000	0.00	0	0.00	0.00			
23	LLLLLLLL	23.000	0.00	0	0.00	0.00			
24	LLLLLLLL	24.000	0.00	0	0.00	0.00			
25	LLLLLLLL	25.000	0.00	0	0.00	0.00			
26	LLLLLLLL	26.000	0.00	0	0.00	0.00			
27	LLLLLLLL	27.000	0.00	0	0.00	0.00			
28	LLLLLLLL	28.000	0.00	0	0.00	0.00			
29	LLLLLLLL	29.000	0.00	0	0.00	0.00			
30	LLLLLLLL	30.000	0.00	0	0.00	0.00			
31	LLLLLLLL	31.000	0.00	0	0.00	0.00			
32	LLLLLLLL	32.000	0.00	0	0.00	0.00			
33	LLLLLLLL	33.000	0.00	0	0.00	0.00			
34	LLLLLLLL	34.000	0.00	0	0.00	0.00			
35	LLLLLLLL	35.000	0.00	0	0.00	0.00			
36	LLLLLLLL	36.000	0.00	0	0.00	0.00			
37	LLLLLLLL	37.000	0.00	0	0.00	0.00			
38	LLLLLLLL	38.000	0.00	0	0.00	0.00			
39	LLLLLLLL	39.000	0.00	0	0.00	0.00			
40	LLLLLLLL	40.000	0.00	0	0.00	0.00			
41	LLLLLLLL	41.000	0.00	0	0.00	0.00			
42	LLLLLLLL	42.000	0.00	0	0.00	0.00			
43	LLLLLLLL	43.000	0.00	0	0.00	0.00			
44	LLLLLLLL	44.000	0.00	0	0.00	0.00			
45	LLLLLLLL	45.000	0.00	0	0.00	0.00			
46	LLLLLLLL								



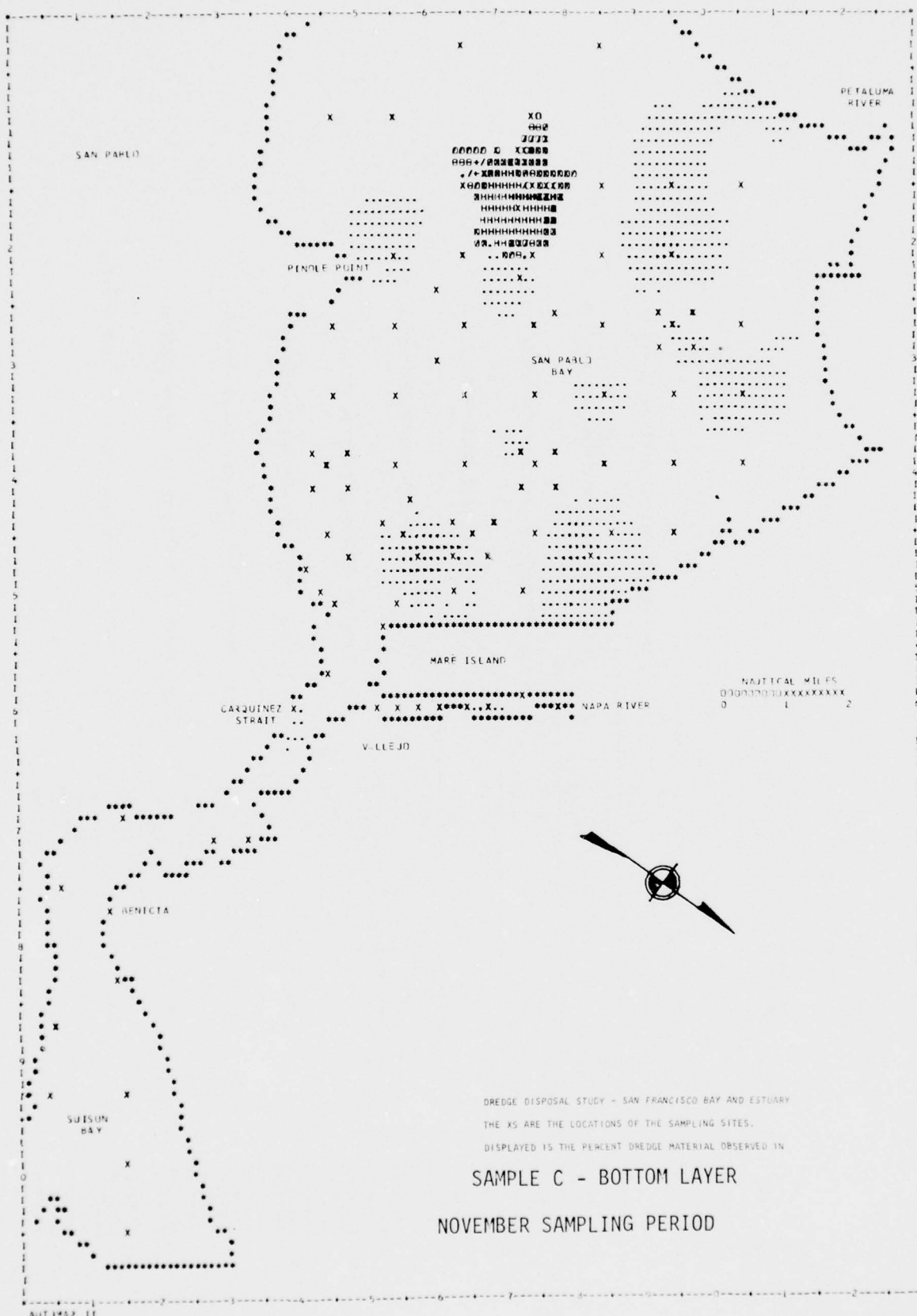
SAMPLE A - TOP LAYER  
NOVEMBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE				0.000	99.000		
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	
LOW	LLLLLLLL	0.000		0	0.00	0.00	
	LLLLLLLL	0.000			0.00		
1		0.000	.50	69	0.00	70.41	ZERO TO ONE HALF PER CENT DREDGE MATERIAL
		.500			70.41		
2		.500	1.50	21	70.41	21.43	ONE HALF TO TWO PER CENT DREDGE MATERIAL
		2.000			91.84		
3		2.000	2.00	3	91.84	3.06	TWO TO FOUR PER CENT DREDGE MATERIAL
		4.000			94.90		
4		4.000	2.00	1	94.90	1.02	FOUR TO SIX PER CENT DREDGE MATERIAL
		6.000			95.92		
5		6.000	2.00	1	95.92	1.02	SIX TO EIGHT PER CENT DREDGE MATERIAL
		8.000			96.94		
6		8.000	2.00	1	96.94	1.02	EIGHT TO TEN PER CENT DREDGE MATERIAL
		10.000			97.96		
7		10.000	10.00	0	97.96	0.00	TEN TO TWENTY PER CENT DREDGE MATERIAL
		20.000			97.96		
8		20.000	20.00	1	97.96	1.02	TWENTY TO FORTY PER CENT DREDGE MATERIAL
		40.000			98.98		
9		40.000	40.00	0	98.98	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL
		80.000			98.98		
10		80.000	20.00	1	98.98	1.02	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL
		100.000			100.00		
HIGH		100.000		0	100.00	0.00	
		100.000			100.00		



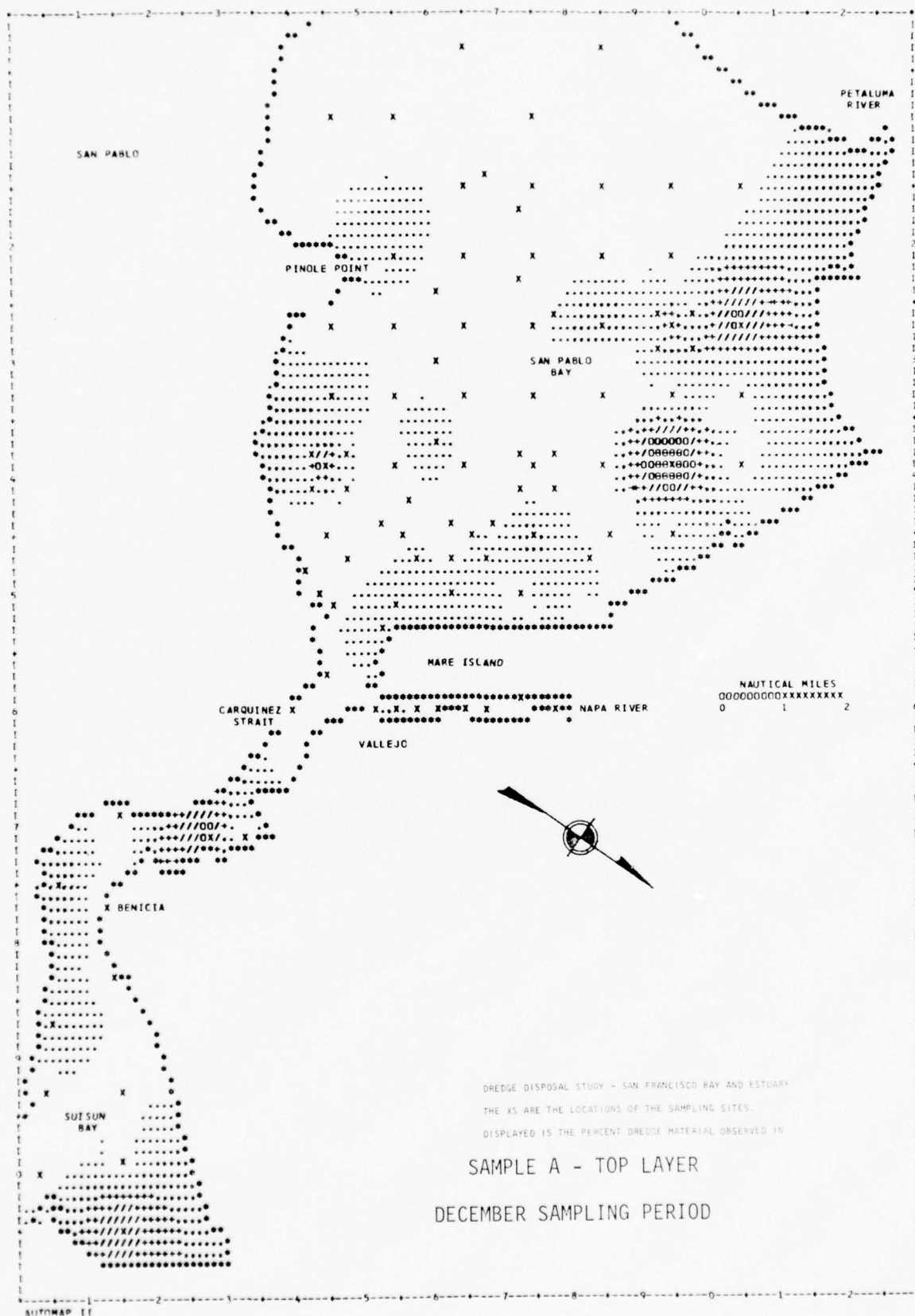
SAMPLE B MIDDLE LAYER  
NOVEMBER SAMPLING PERIOD

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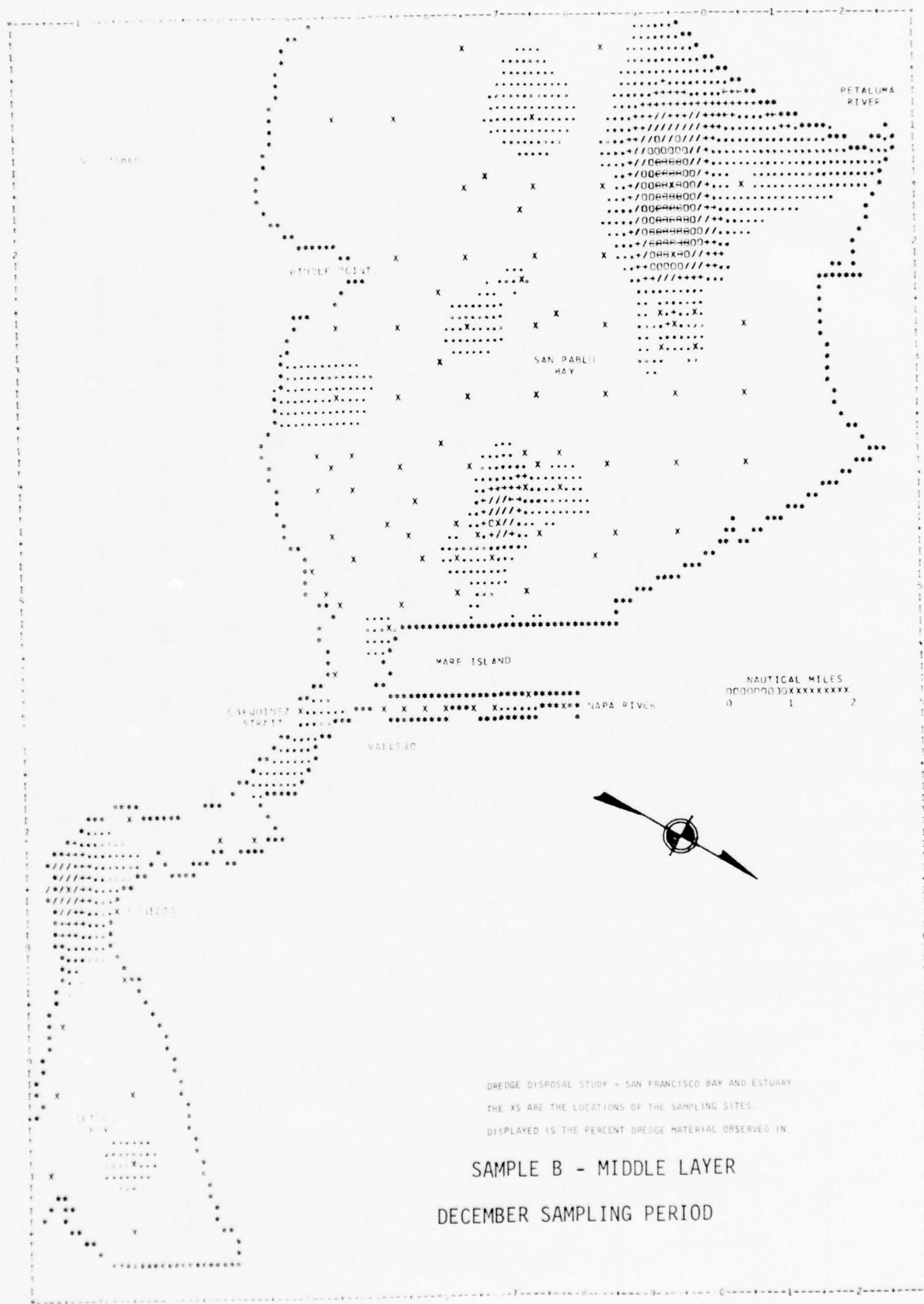
SAMPLE C - BOTTOM LAYER  
 NOVEMBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE							0.000	414.000
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS		
LOW	LLLLLLL	0.000		0	0.00	0.00		
	LLLLLLL	0.000			0.00			
	LLLLLLL	0.000			0.00			
1		0.000	.50	80	0.00	82.47	ZERO TO ONE HALF PER CENT DREDGE MATERIAL	
		.500			87.47			
2		.500	1.50	11	82.47	11.34	ONE HALF TO TWO PER CENT DREDGE MATERIAL	
		2.000			93.61			
3		2.000	2.00	4	93.61	4.12	TWO TO FOUR PER CENT DREDGE MATERIAL	
		4.000			97.94			
4		4.000	2.00	1	97.94	1.03	FOUR TO SIX PER CENT DREDGE MATERIAL	
		6.000			98.97			
5		6.000	2.00	0	98.97	0.00	SIX TO EIGHT PER CENT DREDGE MATERIAL	
		8.000			98.97			
6		3.000	2.00	0	98.97	0.00	EIGHT TO TEN PER CENT DREDGE MATERIAL	
		10.000			98.97			
7		10.000	10.00	0	98.97	0.00	TEN TO TWENTY PER CENT DREDGE MATERIAL	
		20.000			98.97			
8		20.000	20.00	0	98.97	0.00	TWENTY TO FORTY PER CENT DREDGE MATERIAL	
		40.000			98.97			
9		40.000	40.00	0	98.97	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL	
		80.000			98.97			
10		80.000	20.00	0	98.97	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL	
		100.000			98.97			
HIGH		100.000	100.000	1	98.97	1.03		
		414.000			100.00			



SAMPLE A - TOP LAYER  
DECEMBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE							0.000	11.958
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	LLLLLLL	0.000			0.00			
	LLLLLLL	0.000			0.00			
1		0.000	.50	76	0.00	76.77	ZERO TO ONE HALF PER CENT DREDGE MATERIAL	
		.500			76.77			
2		.500	1.50	12	76.77	12.12	ONE HALF TO TWO PER CENT DREDGE MATERIAL	
		2.000			98.89			
3		2.000	2.00	5	88.89	5.05	TWO TO FOUR PER CENT DREDGE MATERIAL	
		4.000			93.94			
4		4.000	2.00	0	93.94	0.00	FOUR TO SIX PER CENT DREDGE MATERIAL	
		6.000			93.94			
5		6.000	2.00	2	93.94	2.02	SIX TO EIGHT PER CENT DREDGE MATERIAL	
		8.000			95.96			
6		8.000	2.00	2	95.96	2.02	EIGHT TO TEN PER CENT DREDGE MATERIAL	
		10.000			97.98			
7		10.000	10.00	2	97.98	2.02	TEN TO TWENTY PER CENT DREDGE MATERIAL	
		20.000			100.00			
8		20.000	20.00	0	100.00	0.00	TWENTY TO FORTY PER CENT DREDGE MATERIAL	
		40.000			100.00			
9		40.000	40.00	0	100.00	0.00	FORTY TO EIGHTY PER CENT DREDGE MATERIAL	
		80.000			100.00			
10		80.000	20.00	0	100.00	0.00	EIGHTY TO ONE HUNDRED PER CENT DREDGE MATERIAL	
		100.000			100.00			
HIGH		100.000		0	100.00	0.00		
		100.000			100.00			



SAMPLE B MIDDLE LAYER  
DECEMBER SAMPLING PERIOD

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89	UUUUUUUU	0.000	0.00	0	0.00
90	UUUUUUUU	0.000	0.00	0	0.00
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96	UUUUUUUU	0.000	0.00	0	0.00
97	UUUUUUUU	0.000	0.00	0	0.00
98	UUUUUUUU	0.000	0.00	0	0.00
99	UUUUUUUU	0.000	0.00	0	0.00
100	UUUUUUUU	0.000	0.00	0	0.00



SAMPLE C - BOTTOM LAYER  
DECEMBER SAMPLING PERIOD

DATA VALUE EXTREMES ARE				0.00	11.765				
LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT AREAS			
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	LLLLLLLL	0.00	0.00	0	0.00	0.00			
	LLLLLLLL	0.00	0.00	0	0.00	0.00			
1		0.00	0.00	72	0.00	72.73	ZERO TO ONE HALF PER CENT DREDGE MATERIAL		
2		0.50	0.50	19	72.73	91.92	ONE HALF TO TWO PER CENT DREDGE MATERIAL		
3		1.00	1.00	6	91.92	97.98	TWO TO FOUR PER CENT DREDGE MATERIAL		
4		2.00	2.00	0	97.98	98.99	FOUR TO SIX PER CENT DREDGE MATERIAL		
5		4.00	4.00	3	98.99	100.00	SIX TO EIGHT PER CENT DREDGE MATERIAL		
6		8.00	8.00	1	100.00	100.00	EIGHT TO TEN PER CENT DREDGE MATERIAL		
7		10.00	10.00	0	100.00	100.00	TEN TO TWENTY PER CENT DREDGE MATERIAL		
8		20.00	20.00	0	100.00	100.00	TWENTY TO FORTY PER CENT DREDGE MATERIAL		
9		40.00	40.00	0	100.00	100.00	FORTY TO ONE HUNDRED PER CENT DREDGE MATERIAL		
10		100.00	100.00	0	100.00	100.00			
HIGH		100.00	100.00	0	100.00	100.00			

INCLOSURE 5

Stanford Research Institute report,  
Numerical Simulation of Dredged Material  
Dispersion - San Pablo Bay (San  
Francisco). Volume I - Model  
Development, and Volume II - User's  
Manual

December 1974

Final Report

EGU-2774

NUMERICAL SIMULATION OF DREDGED MATERIAL  
DISPERSION--SAN PABLO BAY (SAN FRANCISCO)

Volume I--MODEL DEVELOPMENT

By: L. D. Spraggs

Prepared for:

Department of the Army  
San Francisco District, Corps of Engineers  
100 McAllister Street  
San Francisco, California 94102

Contract DACW07-73-C-0075

SRI Project EGU-2774

## SUMMARY

One phase of the Dredge Disposal Study is to develop procedures for predicting the dispersion and deposition of dredged sediment in San Francisco Bay. This report describes a mathematical model which can be used to determine the movement of particles in an estuary. By repeated applications of the mathematical model, the movement of many particles deposited at a dumping site over a period of time can be traced. The model can thus be used to simulate dredged material dispersion and deposition. This model has been computerized for implementation on a CDC 7600 computer system. The computer model is called DREGSIM and is coded primarily for particle movement simulation in the San Pablo Bay area of San Francisco Bay.

Results of extended particle simulations with DREGSIM indicate a large amount of material moves into Mare Island Strait from the current dumping site at the west end of the Carquinez Strait. In addition, significant quantities of material deposited at the current dumping site can be found subsequently at (1) the Carquinez Strait, (2) the southern side of the main channel, (3) areas of the Napa Sloughs, (4) the mouth of the Petaluma River, and (5) the entrance to the central Bay. The results indicate further that loading of Mare Island Strait may occur as a result of sediment entering into the Bay via the Carquinez Strait. The simulation, however, did not indicate movement of particles into the main channel from the current dumping site. There was also no indication that particles entering from the central Bay would cross the main channel and deposit on the northern side of San Pablo Bay; instead, these

particles moved along the south side of the main channel and eventually into the Carquinez Strait.

The DREGSIM model should be given further test runs and results compared with data obtained by the San Francisco Bay Tracing Program. The model can then be modified to provide more accurate predictions of dredged material dispersion and deposition.

Documentation of DREGSIM and instructions for its use are presented in Volume II of this report.

#### ACKNOWLEDGEMENTS

The author would like to express gratitude to Ms. Peggy Garza for her work in computer related areas of this study. Special thanks are due to Mr. Dick Ecker and Mr. John Sustar of the San Francisco District of the U.S. Army Corps of Engineers for their interest and support of this project.

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## I INTRODUCTION

Because of the growing concern for possible adverse effects on nektonic and benthic organisms due to disposal of dredged sediment, more information is needed on the dispersion and deposition of dredged materials. The Material Release study element of the Dredge Disposal Study addresses this question, and one phase of this study element is to develop methods for predicting the long-term fate of deposited dredged materials. This report describes a mathematical model which simulates the movement of particles in an estuary and which can be used to predict the dispersion and deposition of dredged material. Results from the computerized version of the model are also presented. The computer model is called DREGSIM and is coded for the CDC 7600 computer system. The documentation of the computer model and users' instructions will be presented in Volume II of this report.

The primary advantage in using mathematical models to determine the outcome of a particular set of prescribed conditions is the ability to exactly reproduce these conditions for various tests. Also, extreme occurrences of various parameters can easily be generated to test the reaction of the system to extreme conditions.

Clearly, if the final deposition of the dumped dredged materials can be determined mathematically, then mitigative procedures can be developed to remove adverse conditions brought about by current dredging operations. In addition, future dredging operations could be analyzed to determine a method of disposing the dredged materials in the least harmful way.

The mathematical modeling project is closely aligned with the San Francisco Bay Tracing Program being conducted by the San Francisco District, USAEWES Explosive Excavation Research Laboratory and Stanford Research Institute. It is hoped that the information from the tracer program can be used as input for the mathematical model. Conversely, it is expected that the mathematical model will provide information for the tracer program.

This effort has made use of previous modeling efforts wherever feasible and practicable, modifying and changing existing work to make the model more useful in the established tasks.

## II OBJECTIVES

The objectives of the current study are to:

- Perform a limited literature search to determine the extent of dredged material modeling.
- Incorporate a material transport model into an existing estuary model.
- Assemble existing data.
- Simulate various conditions in San Francisco Bay in the area of Mare Island.
- Prepare a report and recommend future modeling projects.

The study is more concerned with simulating the characteristics of dredged material dispersion in San Francisco Bay than with developing a rigorous numerical model with general applicability. In this respect, it is important to simulate many varying conditions so as to obtain information about the unique characteristics of the Bay. Data for the model were obtained from existing data sources.

### III METHOD OF APPROACH

#### 3.1 Theoretical Considerations

##### 3.1.1 Introduction

This section describes an approach to numerical simulation of dredged materials dispersion in San Francisco Bay. In particular, the principles of estuarine hydrodynamic and sedimentation were applied to study the transport and dispersion of dredged materials in the northern portion of the Bay. The procedure is concerned with extracting information about the physical system from numerical experimentation in conjunction with truth data obtained from the San Francisco Bay Tracing Program. As such, the procedure is not concerned with developing new numerical models but utilizes existing models as much as possible.

Accurate mathematical simulation and prediction of any natural phenomenon must be preceded by an intimate understanding of all the components contributing to the final outcome. From this understanding can be developed a mathematical relationship that describes an outcome for a particular set of circumstances and, depending on the complexity of the model, a solution can be found. Generally, the mathematical model is formulated for a continuum, but because analytical solutions are impossible, the problem is solved numerically at a finite number of discrete points and extrapolated to neighboring points of the continuum. This process of discretization introduces a number of deviations from real behavior, depending on the numerical technique chosen and the spacing of the solution points (mesh or grid points). Therefore, before the

technical details of the current study are presented it is important to present the rationale underlying the model.

A mathematical model can be thought of as a mathematical analog of its prototype counterpart. Generally, the mathematical expressions of the relevant physical processes are established and assembled to form the mathematical model. The model is then simplified by neglecting those components that are obviously not influencing the prototype to a great degree. Finally, the model is solved, either analytically, numerically, or with another analog, depending on the complexity of the final model. The final solution is intended to describe (within tolerable limits) the action of the components of the prototype to some imposed constraints. The accuracy of the simulation will depend on the suitability of the choice of simplifying assumptions and on the quantity and quality of data available for calibrating the model.

### 3.1.2 Statement of the Problem

This study treats the movement of specially marked dredged materials in an estuary influenced by tidal action. Figure 3.1 shows the extent of the study area and indicates the important landmarks for orientation purposes. The motion and subsequent position of a particle will be governed by the fluid velocity, density and pressure, and the particle size and density. A model is developed for estimating the motion of the dredged materials disposed of within the estuaries.

The basic three dimensional hydrodynamic equations governing the fluid motion are first transformed into usable form for the case of a well mixed estuary. These equations include the effect of wind, bottom stress, tidal action and turbulent diffusion. Then, the equations governing the motion of a single particle in a moving fluid are presented. Finally, an equation expressing the mean concentration in a column of water is included.

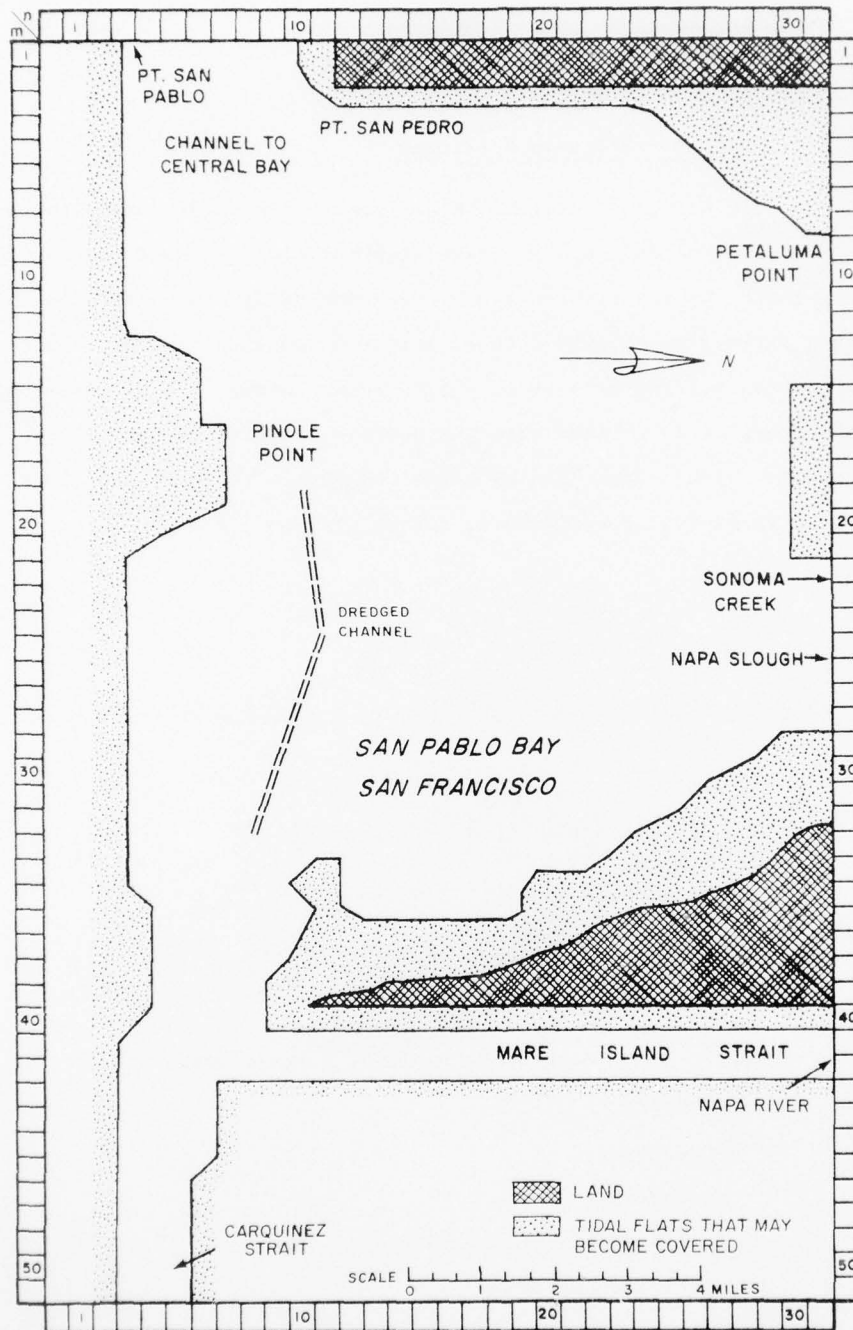


FIGURE 3.1 SAN PABLO BAY

### 3.2 The Governing Equations

#### 3.2.1 Basic Hydrodynamic Equations

The motion of a fluid in an estuary can be described in terms of its velocity, density and pressure (temperature is assumed to be constant). These three variables can be mathematically represented by five equations expressing conservation of momentum and mass, and an equation of state which relates density to the existing temperature and pressure. For this study it is assumed that the density effects are negligible and that density can be considered as being constant. The remaining four equations, in cartesian coordinates can be expressed as:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \quad (3.1)$$

$$\frac{\partial u}{\partial t} + \frac{\partial(uu)}{\partial x} + \frac{\partial(uv)}{\partial y} + \frac{\partial(uw)}{\partial z} = -\frac{1}{\rho} \frac{\partial P}{\partial x} + f_v + v' \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) \quad (3.2)$$

$$\frac{\partial v}{\partial t} + \frac{\partial(vu)}{\partial x} + \frac{\partial(vv)}{\partial y} + \frac{\partial(vw)}{\partial z} = -\frac{1}{\rho} \frac{\partial P}{\partial y} - f_u + v' \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2} \right) \quad (3.3)$$

$$\frac{\partial w}{\partial t} + \frac{\partial(wu)}{\partial x} + \frac{\partial(vw)}{\partial y} + \frac{\partial(ww)}{\partial z} = -\frac{1}{\rho} \frac{\partial P}{\partial z} - g + v' \left( \frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2} \right) \quad (3.4)$$

where u, v, w = velocity components in x, y, z direction

$\rho$  = density

P = pressure

$v'$  = viscosity

g = gravitational acceleration

f = coriolis parameter

When appropriate initial and boundary conditions are specified, these equations completely describe the time-dependent fluid motion.

Unfortunately, no closed form solution exists, and the equations are too

complex to be given rigorous numerical treatment. Therefore, approximation based on the physics of the study area must be introduced to simplify the equations and make them amenable to solution with a high speed digital computer. At this juncture it is assumed that the equations are written for mean flows and that the viscosity term ( $\nu'$ ) includes the turbulent eddy diffusion contribution.

### 3.2.2 Approximations

The following assumptions are made concerning the San Pablo Bay area of San Francisco Bay:

1. The estuary is essentially well mixed.
2. Vertical velocities and vertical fluid accelerations are negligible.
3. The tidal action of the estuary is a result only of the oceanic tide at the estuary mouth.
4. As a general rule, the fresh water flows will be unimportant when compared with the tidal flows.
5. Due to the fresh water inflows, there will always be a net flow seaward. These inflows can be accounted for by proper prescription of the boundary at the freshwater source.
6. The density of the receiving water ( $\rho$ ) is not altered appreciably by the disposal of the dredged materials. Hence, the equations of 3.2.1 are still appropriate.

Because the estuary is well mixed and the vertical velocities are small, the equations of motion can be integrated over the vertical. The pressure ( $P$ ) can be assumed to be hydrostatic, that is:

$$P = g(\bar{\xi} - z) + P_o \quad (3.5)$$

where  $\bar{\xi}$  = surface elevation

$P_o$  = surface pressure.

The first, second, and sixth assumptions listed above are simplifications of the complex hydrodynamics of an estuary; such simplifications are necessary to constrain the model development to manageable proportions. If tidal flows are considered to be the predominant force in the movement of particles in the Bay, then these simplifications would not affect the computed results significantly. The third assumption is valid for San Pablo Bay because the Bay is relatively small and tidal differences within it are insignificant. The fourth assumption is valid for San Pablo Bay under conditions of low fresh water inflow during the summer and fall months. The higher fresh water inflow during the winter and spring months will certainly have a greater influence on the movement of sediment in the Bay; however, the model still considers the tidal flows to be the predominant factor. The fifth assumption implies fresh water inflow data are available and open landward boundaries of the estuary can be specified accurately.

### 3.2.3 Vertically Integrated Equations of Motions

Introducing the approximations into Eqs. (3.1)-(3.4), integrating from the bottom to the surface and introducing the appropriate boundary conditions leads to:

$$\frac{\partial \bar{U}}{\partial t} + \bar{U} \frac{\partial \bar{U}}{\partial x} + \bar{V} \frac{\partial \bar{U}}{\partial y} = f\bar{V} - g \frac{\partial \bar{\xi}}{\partial x} - \frac{1}{\rho} \frac{\partial P_o}{\partial x} - \frac{T_{bx} - T_{wx}}{\lambda} + \bar{v}' \left( \frac{\partial^2 \bar{U}}{\partial x^2} + \frac{\partial^2 \bar{U}}{\partial y^2} \right) \quad (3.6)$$

$$\frac{\partial \bar{V}}{\partial t} + \bar{U} \frac{\partial \bar{V}}{\partial x} + \bar{V} \frac{\partial \bar{V}}{\partial y} = -f\bar{U} - g \frac{\partial \bar{\xi}}{\partial y} - \frac{1}{\rho} \frac{\partial P_o}{\partial y} - \frac{T_{by} - T_{wy}}{\lambda} + \bar{v}' \left( \frac{\partial^2 \bar{V}}{\partial x^2} + \frac{\partial^2 \bar{V}}{\partial y^2} \right) \quad (3.7)$$

$$\frac{\partial \bar{\xi}}{\partial t} + \frac{\partial}{\partial x} (\lambda \bar{U}) + \frac{\partial}{\partial y} (\lambda \bar{V}) = 0 \quad (3.8)$$

where  $\lambda = \bar{\xi} + h$

$h$  = depth

overbars indicate a vertical average.

Subsequently, all the vertically averaged variables will be written without overbars. Equations (3.6), (3.7) and (3.8) constitute the mathematical model used in this study to determine the fluid motions in the estuary. The bottom stress terms ( $T_{bx}$ ,  $T_{by}$ ) and the wind stress terms ( $T_{wx}$ ,  $T_{wy}$ ) are defined as follows:

$$\begin{aligned} T_{bx} &= \frac{\rho g}{C^2} \frac{U(U^2 + V^2)^{1/2}}{\lambda} \\ T_{by} &= \frac{\rho g}{C^2} \frac{V(U^2 + V^2)^{1/2}}{\lambda} \\ T_{wx} &= \frac{\rho_a}{\rho} \frac{C_D W_x (W_x^2 + W_y^2)^{1/2}}{\lambda} \\ T_{wy} &= \frac{\rho_a}{\rho} \frac{C_D W_y (W_x^2 + W_y^2)^{1/2}}{\lambda} \end{aligned} \quad (3.9)$$

where  $W_x, W_y$  = wind speed components

$C$  = Chezy coefficient

$C_D$  = suitable drag coefficient ( $\sim .0013$ )

$$\frac{\rho_a}{\rho} = \frac{\text{density of air}}{\text{density of water}} \quad (\sim .0012)$$

The apparent viscosity  $v'$  is given by the relationship

$$v' = v + \epsilon \quad (3.10)$$

$$\text{where } \epsilon = \Lambda \frac{1}{x} \frac{1}{y} \left\{ S_{xx}^2 + S_{yy}^2 + 2S_{xy} S_{xy} \right\}$$

$\Lambda$  = scaling parameter

$l_x, l_y$  = length scales

$$S_{xx}, S_{yy}, S_{xy} = 2 \frac{\partial U}{\partial x}, 2 \frac{\partial V}{\partial y}, \frac{\partial U}{\partial y} + \frac{\partial V}{\partial x}$$

$v$  = viscosity of water

### 3.2.4 Particle Movement

The settling and movement of suspended particles in the estuary is a function of the hydrodynamics at work, as well as the size and shape of the particle and the chemical composition of the water and particle. The settling of the particles will be controlled by the size and density of the particle and the vertical accelerations of the water. According to Murry<sup>1</sup> the vertical velocity of a suspended particle can be modeled by:

$$\frac{dW_p}{dt} = \frac{F}{\rho_p V_p} - \frac{g(\rho_p - \rho_w)}{\rho_p} - \frac{\rho_w}{\rho_p} \left( \frac{KdW_p}{dt} - \frac{dW}{dt} \right) \quad (3.11)$$

where  $W_p$  is the instantaneous particle velocity,  $F$  is the drag force given by

$$F = \frac{\pi}{8} C_D \rho_w d^2 |W_o| W_o, \quad (3.12)$$

$g$  is the gravitational acceleration,  $\rho_w$  is the fluid density,  $K$  is the coefficient of added mass,  $V$  is the particle volume,  $W_o$  is the relative particle speed,  $W$  is the vertical water velocity,  $C_D$  is the coefficient of drag, and  $d$  is the particle diameter. If the absolute particle speed  $W_o$  is defined as  $W_o = W - W_p$ , then Eq. (3.11) can be rewritten as

$$\begin{aligned} \frac{dW_o}{dt} = & - \frac{dW}{dt} \left( 1.0 - \frac{\rho_w}{\rho_p} \left( \frac{1+K}{1+K\rho_w/\rho_p} \right) \right) - \frac{3}{4} \frac{C_D}{d} \frac{\rho_w W_o |W_o|}{\left( 1 + \frac{K\rho_w}{\rho_p} \right) \rho_p} \\ & - \left( \frac{\rho_p - \rho_w}{\rho_p \left( 1 + \frac{K\rho_w}{\rho_p} \right)} \right) g \end{aligned} \quad (3.13)$$

Defining the particle Reynolds number ( $R_{ep}$ ) =  $W_{pt} d/v$  where  $W_{pt}$  is the terminal settling velocity,  $d$  is the particle diameter and  $v$  is the kinematic viscosity, the drag coefficient<sup>2</sup> ( $C_D$ ) is assumed to be

$$C_D = \frac{24}{R_e} f(R_e) \quad (3.14)$$

where  $f(R_e) = 1.0$

$$R_e < 0.5$$

$$= \left( 1.0 + \frac{3}{16} R_e \right)^{1/2} \quad R_e \leq 0.5 < 1.0$$

$$= 1.0 + .197 R_e^{.63} + .0026 R_e^{1.38} \quad 1.0 \leq R_e \leq 100$$

$$= 1.0 + .150 R_e^{0.687} \quad 100.0 < R_e$$

The terminal settling velocity of a spherical particle falling in quiescent water is

$$W_{pt} \cong - \left[ \frac{4}{3} \frac{dg}{C_D} \left( \frac{\rho_p - \rho_w}{\rho_w} \right) \right]^{1/2} \quad (3.15)$$

where  $\rho_p, \rho_w$  = density of particle, water  
 $g$  = gravitational acceleration.

Note that the drag coefficient, Reynolds number and terminal velocity must be solved by iterative procedures.

### 3.2.5 Basic Sediment Transport Equation

McLaughlin<sup>3</sup> gives the general basic equation for the transport of fine sediments based on the conservation of sediment mass. For two-dimensional flow the equation is:

$$\frac{\partial S}{\partial t} = -U \frac{\partial S}{\partial x} - V \frac{\partial S}{\partial y} + \frac{\partial}{\partial x} \left( \epsilon_x \frac{\partial S}{\partial x} \right) + \frac{\partial}{\partial y} \left( \epsilon_y \frac{\partial S}{\partial y} \right) + S_{io} \quad (3.16)$$

where  $S$  is the concentration and  $S_{io}$  is the contribution from sources and sinks. Boundary conditions and initial conditions must be specified before Eq. (3.16) can be solved. The boundary conditions assumed in this study are

$$\frac{\partial S}{\partial n} = 0 \quad \text{at solid boundaries}$$

$S$  = specified at open boundaries.

Using the velocity field obtained from Eq. (3.6) and Eq. (3.7), Eq. (3.16) can be numerically integrated to obtain concentrations at each point in the estuary.

## IV NUMERICAL MODEL

### 4.1 Notation

Transformation of a mathematical model into a usable numerical model is accompanied by a large proliferation of terms. To avoid the problems associated with the numerical representations of spatial and temporal derivatives, the following definitions are used:

1.  $n, i, j$  - denote time,  $x$  and  $y$  respectively.
2.  $\left\langle \right\rangle_{i,j}^n$  - indicates a finite difference analog of the quantity inside the brackets centered at  $i, j, n$ .

3. Whenever  $i, j, n$  appear without modification they are dropped but implied, i.e.

$$U_{i+1/2, j}^n = U_{i+1/2}$$

4. Linear interpolation is used to obtain variables at points where they are not defined.

5. Repeated indices other than  $i$  or  $j$  indicate summation, i.e.

$$\frac{U_{m+1/2} - U_{m-1/2}}{\Delta x_m} = \frac{U_{i+1/2} - U_{i-1/2}}{\Delta x} + \frac{V_{j+1/2} - V_{j-1/2}}{\Delta y}$$

Note that  $i$  and  $j$  and  $x$  and  $y$  are used interchangeably as expansion proceeds.

6. Summation is never implied with  $i$  or  $j$ .

As an example of the use of these definitions the following equation

$$\frac{\partial \alpha}{\partial t} + \frac{\partial (U\alpha)}{\partial x} + \frac{\partial (V\alpha)}{\partial y} = R$$

will be given in the conventional and compacted finite difference forms, i.e.

$$\frac{\alpha_{i,j}^{n+1} - \alpha_{i,j}^n}{\Delta t} + \frac{(U\alpha)_{i+1/2,j}^n - (U\alpha)_{i-1/2,j}^n}{\Delta x} + \frac{(V\alpha)_{i,j+1/2}^n - (V\alpha)_{i,j-1/2}^n}{\Delta y} = R_{i,j}^n$$

is equivalent to

$$\frac{\alpha_{i,j}^{n+1} - \alpha_{i,j}^n}{\Delta t} + \frac{(U\alpha)_{m+1/2}^n - (U\alpha)_{m-1/2}^n}{\Delta x_m} = R$$

Deviations from the above format will always be specified.

#### 4.2 Velocities and Surface

The finite difference analogs of Eqs. (3.6), (3.7), and (3.8) are derived in an analogous manner to that given by Leendertse,<sup>4</sup> that is:

$$C_1 \left\langle \frac{\partial \xi}{\partial x} \right\rangle_{j+1/2}^{n+1/2} + C_2 U_{j+1/2}^{n+1/2} = U_{j+1/2} + \frac{1}{2} \Delta t \left\{ V_{j+1/2} \left( f - \left\langle \frac{\partial U}{\partial j} \right\rangle_{j+1/2} \right) - R_{x(j+1/2)} + F_{x(j+1/2)} - D_{x(j+1/2)} \right\} \quad (4.1)$$

$$\frac{1}{2} \Delta t \left\langle \frac{\partial (VU^{n+1/2})}{\partial x} \right\rangle_{i,j} + \xi^{n+1/2} = \xi - \frac{1}{2} \Delta t \left\langle \frac{\partial (VW)}{\partial y} \right\rangle \quad (4.2)$$

$$C_3 V_{i+1/2}^{n+1/2} = V_{i+1/2} + \frac{1}{2} \Delta t \left\{ U_{i+1/2}^{n+1/2} \left( -f - \left\langle \frac{\partial V}{\partial x} \right\rangle_{i+1/2} \right) - g \left\langle \frac{\partial \xi}{\partial y} \right\rangle_{i+1/2} + F_y + D_y \right\} \quad (4.3)$$

$$C_1 \left\langle \frac{\partial \xi}{\partial y} \right\rangle^{n+1} + C_4 V_{i+1/2}^{n+1} = V_{i+1/2}^{n+1/2} + \frac{1}{2} \Delta t \left\{ U_{i+1/2}^{n+1/2} \left( -f - \left\langle \frac{\partial V}{\partial x} \right\rangle_{i+1/2}^{n+1/2} \right) - R_y^{n+1/2} + F_y^{n+1/2} + D_y^{n+1/2} \right\} \quad (4.4)$$

$$\frac{1}{2} \Delta t \left\langle \frac{\partial}{\partial y} (\gamma^{n+1/2} v^{n+1}) \right\rangle_{i,j} + \xi^{n+1} = \xi^{n+1/2} - \frac{1}{2} \Delta t \left\langle \frac{\partial (\gamma^{n+1/2} u^{n+1/2})}{\partial x} \right\rangle_{i,j} \quad (4.5)$$

$$C_5 U_{i+1/2}^{n+1} = U^{n+1/2} + \frac{1}{2} \Delta t \left\{ v_{j+1/2}^{n+1} \left( f - \left\langle \frac{\partial U}{\partial y} \right\rangle_{j+1/2}^{n+1/2} \right) - g \left\langle \frac{\partial v}{\partial x} \right\rangle_{j+1/2}^{n+1/2} + F_x^{n+1/2} + D_y^{n+1/2} \right\} \quad (4.6)$$

$$\text{where } C_1 = \frac{1}{2} \Delta t g$$

$$C_2 = 1.0 + \frac{1}{2} \Delta t \left\langle \frac{\partial U}{\partial x} \right\rangle_{j+1/2}$$

$$C_3 = 1.0 + \frac{1}{2} \Delta t \left[ \left\langle \frac{\partial v}{\partial y} \right\rangle_{i+1/2} + \bar{R}_y(i+1/2) \right]$$

$$C_4 = 1.0 + \frac{1}{2} \Delta t \left\langle \frac{\partial v}{\partial y} \right\rangle_{j+1/2}^{n+1/2}$$

$$C_5 = 1.0 + \frac{1}{2} \Delta t \left[ \left\langle \frac{\partial U}{\partial x} \right\rangle_{j+1/2}^{n+1/2} + \bar{R}_x(j+1/2) \right]$$

$$R_x = \frac{gU(U^2 + v^2)^{1/2}}{\gamma C^2} ; \quad \bar{R}_x = \frac{R_x}{U}$$

$$R_y = \frac{gV(U^2 + v^2)^{1/2}}{\gamma C^2} ; \quad \bar{R}_y = \frac{R_y}{V}$$

$$F_x = \left( \frac{C_{D_a}^{\rho}}{\rho_w} \right) \frac{W_x (W_x^2 + W_y^2)^{1/2}}{\gamma}$$

$$F_y = \left( \frac{C_{D_a}^{\rho}}{\rho_w} \right) \frac{W_y (W_x^2 + W_y^2)^{1/2}}{\gamma}$$

$$\gamma = h + \xi$$

$$D_x = \frac{\partial(\epsilon_{xx} S_{xx})}{\partial x} + \frac{\partial(\epsilon_{xy} S_{xy})}{\partial y}$$

$$D_y = \frac{\partial(\epsilon_{yx} S_{yx})}{\partial x} + \frac{\partial(\epsilon_{yy} S_{yy})}{\partial y}$$

$$S_{xx} = 2 \frac{\partial U}{\partial x} ; \quad S_{xy} = \frac{\partial U}{\partial x} + \frac{\partial V}{\partial y} = S_{yx} ; \quad S_{yy} = 2 \frac{\partial V}{\partial y}$$

This system of finite differencing uses a space-staggered grid scheme as shown in Figure 4.1 and Figure 4.2 (FORTRAN compatible).

Solution of Eqs. (4.1) through (4.6) consists of the following 4 steps:

1.  $U^{n+1/2}, \xi^{n+1/2}$
2.  $V^{n+1/2}$
3.  $V^{n+1}, \xi^{n+1}$
4.  $U^{n+1}$

Steps 1 and 3 are implicit and steps 2 and 4 are explicit. Figure 4.3 shows the solution process schematically. Simple modifications are required to include a more accurate second upwind differencing scheme. At the end of each time step the support variables and boundary conditions are updated and the process is repeated. The eddy diffusion coefficients are computed according to the following finite difference analog.<sup>5</sup>

$$\epsilon_{i,j} = (.01)(\Delta x \Delta y) \left[ \left\langle \frac{\partial U}{\partial x} \right\rangle^2 + \left\langle \frac{\partial V}{\partial y} \right\rangle^2 + 2 \left\langle \frac{\partial U}{\partial y} \frac{\partial V}{\partial x} \right\rangle \right] . \quad (4.7)$$

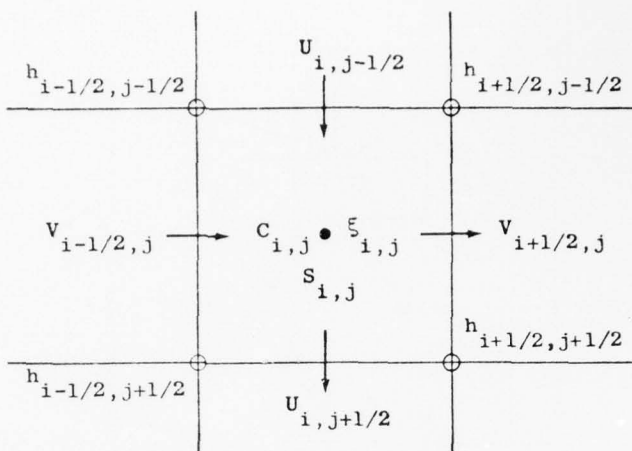


FIGURE 4.1 SPACE-STAGGERED GRID

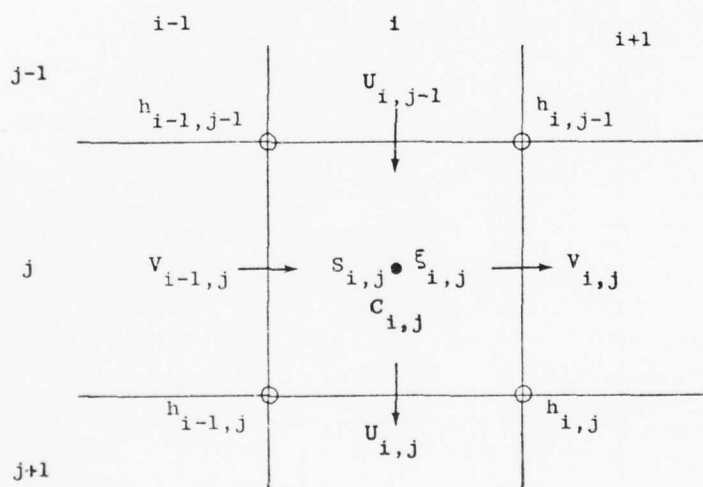


FIGURE 4.2 SPACE-STAGGERED GRID -- FORTRAN

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DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)  
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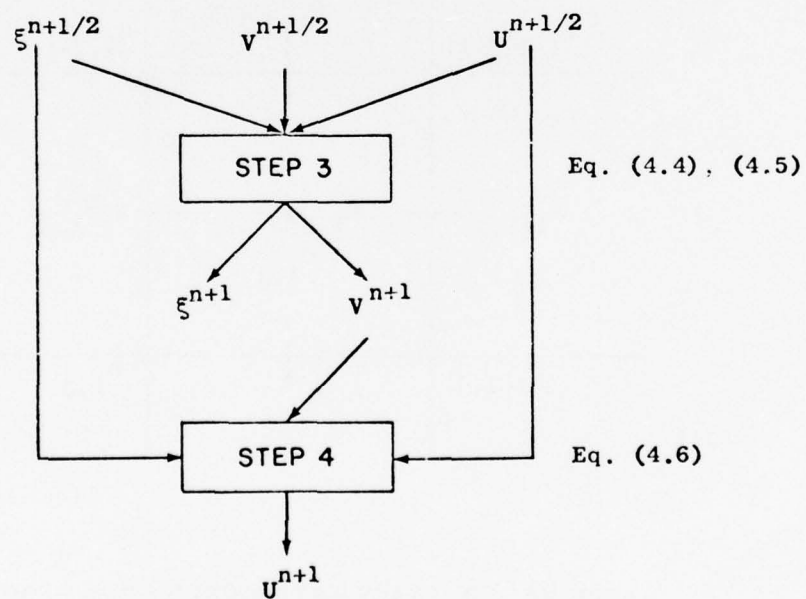
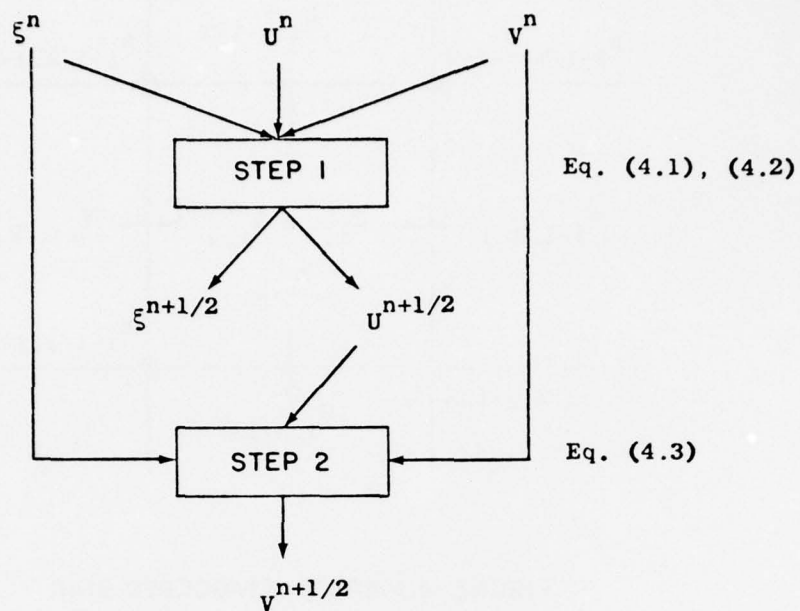


FIGURE 4.3 HYDRODYNAMICS SOLUTION

#### 4.3 Mean Concentration

Eq. (3.16) is reformulated as follows:

$$\begin{aligned}
 S^{n+1} - S = & \frac{\Delta t}{2\Delta x} \left[ U_{j-1/2}^{n+1/2} (S + S_{j-1}) - U_{j+1/2}^{n+1/2} (S + S_{j+1}) \right] \\
 & + \frac{\Delta t}{2\Delta y} \left[ V_{i-1/2}^{n+1/2} (S + S_{i-1}) - V_{i+1/2}^{n+1/2} (S + S_{i+1}) \right] \\
 & + \frac{\Delta t}{\Delta x^2} \left[ \epsilon_{j+1/2} (S_{j+1} - S) - \epsilon_{j-1/2} (S - S_{j-1}) \right] \\
 & + \frac{\Delta t}{\Delta y^2} \left[ \epsilon_{i+1/2} (S_{i+1} - S) - \epsilon_{i-1/2} (S - S_{i-1}) \right] + \Delta t S_{io} \quad (4.8)
 \end{aligned}$$

Eq. (4.8) is solved following the solution of the velocity field to obtain the new concentration levels. The quantities required at the half time-step are computed as a simple average of the  $n$  and  $n+1$  time levels.

#### 4.4 Tracer Particles

The numerical simulation model determines where a "tagged" dredged particle would go after it was released at an estuarine disposal site. The particles are treated as Lagrangian variables, possessing both mass and shape, and are subjected to the numerically calculated velocity field. This procedure is subject to some serious limitations which will be discussed following the presentation of the numerical scheme.

The settling velocity of the particles can be obtained by integrating Eq. (3.13) using an Adam-Bashforth predictor corrector scheme. This scheme does not depend on the location of the grid but is applied at the current location of the particle.

The actual motion of the particle is obtained by interpolating for the horizontal convecting velocities and then using these velocities to move the particles. Given that a particle is under a cell (i,j), then the convecting velocities  $U_c$  and  $V_c$  are given by (Figure 4.4):

$$\begin{aligned}
 U_c = U_o + \frac{1}{2} \left[ \frac{\delta x}{\Delta x} (U_1 - U_3) + \frac{\delta y}{\Delta y} (U_2 - U_4) \right. \\
 + \left( \frac{\delta x}{\Delta x} \right)^2 (U_1 + U_3 - 2U_o) + \left( \frac{\delta y}{\Delta y} \right)^2 (U_2 + U_4 - 2U_o) \\
 \left. + \frac{1}{2} \left( \frac{\delta x}{\Delta x} \right) \left( \frac{\delta y}{\Delta y} \right) (U_5 - U_6 + U_7 - U_8) \right], \quad (4.9)
 \end{aligned}$$

$$\begin{aligned}
 V_c = V_o + \frac{1}{2} \left[ \frac{\delta x}{\Delta x} (V_1 - V_3) + \frac{\delta y}{2\Delta y} (V_2 - V_4) \right. \\
 + \left( \frac{\delta x}{\Delta x} \right)^2 (V_1 + V_3 - 2V_o) + \left( \frac{\delta y}{\Delta y} \right)^2 (V_2 + V_4 - 2V_o) \\
 \left. + \frac{1}{2} \left( \frac{\delta x}{\Delta x} \right) \left( \frac{\delta y}{\Delta y} \right) (V_5 - V_6 + V_7 - V_8) \right] \quad (4.10)
 \end{aligned}$$

Then the new position of the particles is found from the three equations

$$\begin{aligned}
 X^{n+1} &= X^n + \Delta t U_c^{n+1/2} \\
 Y^{n+1} &= Y^n + \Delta t V_c^{n+1/2} \\
 Z^{n+1} &= Z^n + \Delta t W_p^{n+1/2}
 \end{aligned} \quad (4.11)$$

where X, Y, Z are the coordinates with respect to the reference corner.

One problem that arises in this method is that a velocity profile can not be generated from the transport (averaged) velocity without using an empirical distribution. Also, the effect of the fresh-water inflows cannot be adequately handled. To overcome these difficulties some discretionary judgments about the velocity profile for depth and transport

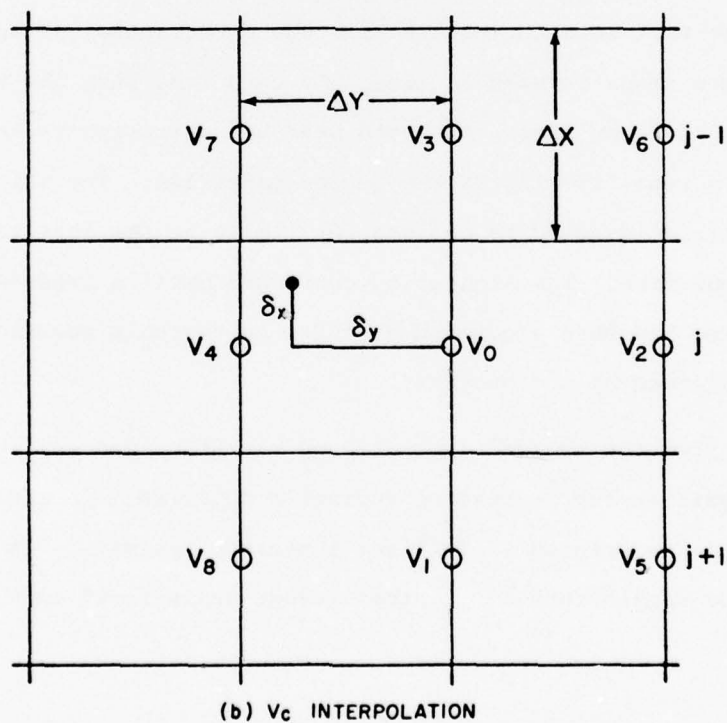
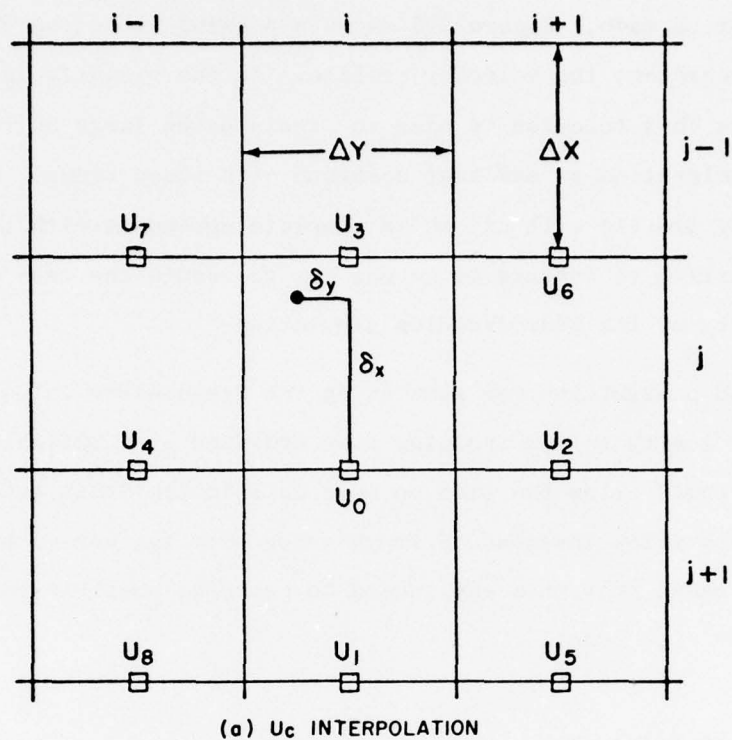


FIGURE 4.4 VELOCITY INTERPOLATION SCHEME

velocity must be made. Figure 4.5 shows a possible function that might be used to represent the velocity profile. In the vicinity of fresh-water inflows this function is used to simulate the large bottom flows causing the migration of sediment upstream with flood tides. Although this velocity profile will not be in complete agreement with the actual velocity profile, it appears to be one way to reduce the two-dimensionality of the hydrodynamics simulation.

A second possibility for simulating the fresh-water inflow is to couple the velocity to the incoming tide modified by a suitable delay. This method would allow the tide to move up into the fresh water on flood tide and would allow movement of fresh water into the bay on the ebb tide. Testing has shown that this may indeed be the best possible boundary condition for this model.

#### 4.5 Method of Solution

The numerical solution begins with the prescription of an initial state and then steps forward in time. At each time step the velocity distribution is found first, then the mean concentration is calculated, followed by a repositioning of the tracer particles. The initial state may be specified, assumed to be zero, or simply be the last time-step of a previous simulation. The simulation continues until a predetermined length of time has been simulated or until an unstable numerical calculation is obtained by the program.

Output from the program is stored on magnetic tape for subsequent visual analysis or for restarting another simulation. In addition, the last time-step is printed in full for immediate analysis. It is possible to use stored simulations for further tracer analysis if such a study is desired.

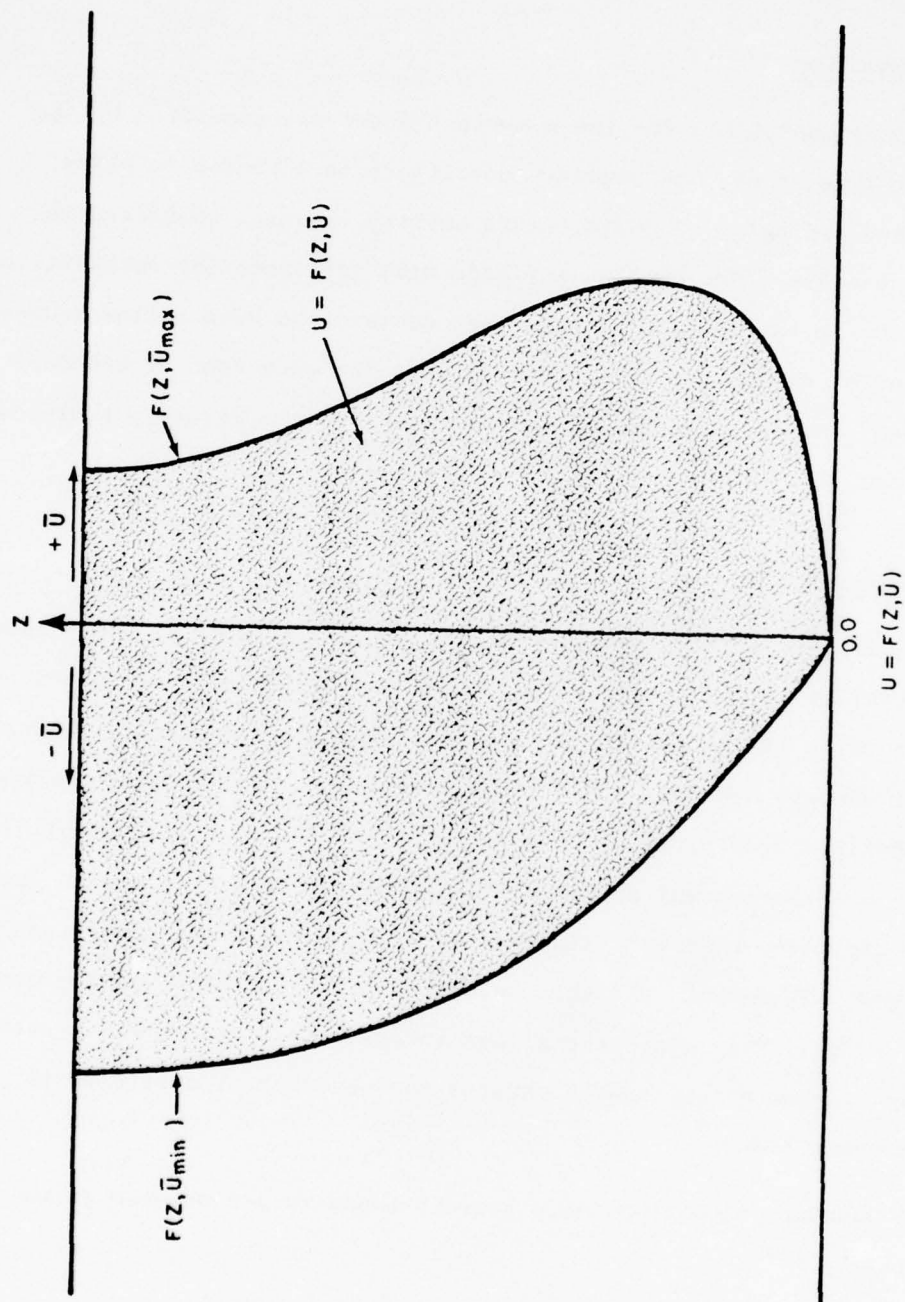


FIGURE 4.5 FUNCTIONS USED TO REPRESENT THE PARTICLE VELOCITY PROFILE

## V BOUNDARY CONDITIONS

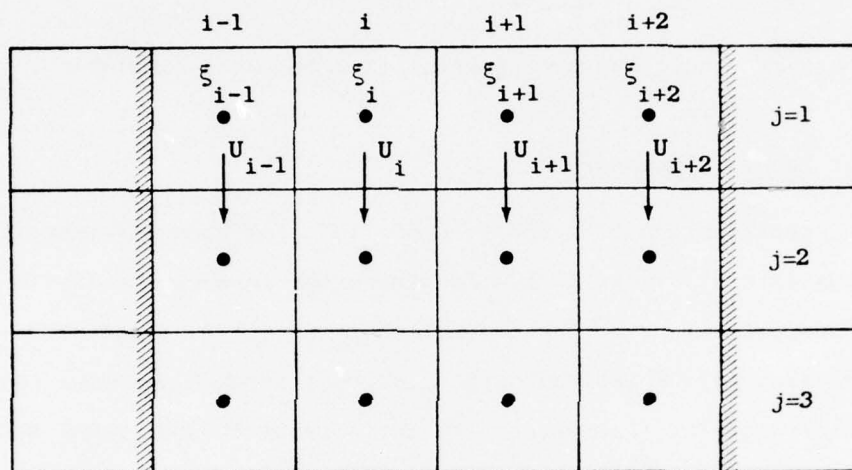
### 5.1 Introduction

Boundary conditions for the numerical model are specified by the user. For this study, the boundary conditions were chosen to allow flooding and drying up of cells. This ability requires considerable checking, because a dry cell on any side will influence the calculation. In addition, it is possible to have open seaward and open inflow boundaries. A brief discussion will be given here for each type of boundary encountered. Other orientations of the same type are directly analogous and will not be discussed.

### 5.2 Open Seaward Boundary

At least one seaward boundary occurs (by definition) in every estuary. In our model it is characterized by having a known or prescribed tide which generally is the predominant forcing function. Figure 5.1 shows a typical seaward boundary. The tidal elevation at the seaward entrance can be obtained from tidal records for input to the numerical model. However, for experimental purposes it is often desirable to use an empirical tide generator so that variable time steps and extreme conditions can be analyzed. Therefore, a simple numerical tide generator was implemented for this study. This generator allows the program to quickly generate tides for extreme events and to examine the reaction of particles to many different tides.

The boundary conditions at a seaward boundary are assumed to be (Fig. 5.1):



$\xi_{i-1}, \xi_i, \xi_{i+1}, \xi_{i+2}$  are all set

$U_{i-1}, U_i, U_{i+1}, U_{i+2}$  are all calculated

FIGURE 5.1 OPEN SEAWARD BOUNDARY

$\xi$  = calculated or prescribed

$$\frac{\partial U}{\partial x} = 0.0; \quad U_{j-1} = U_{j+1}$$

$$\frac{\partial S}{\partial x} = 0.0; \quad S_{i-1} = S_i$$

$$\frac{\partial C}{\partial x} = 0.0; \quad C_{i-1} = C_i$$

(5.1)

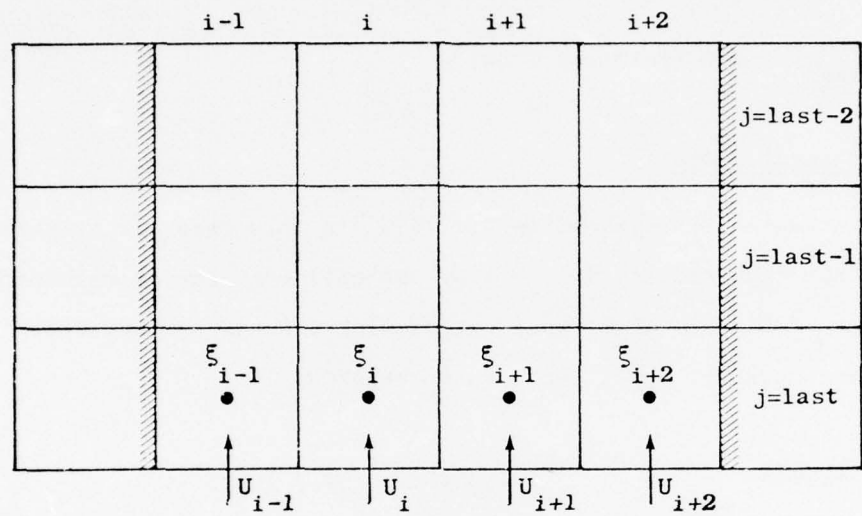
no lateral velocity;  $V_{i,j-1}$ , and  $V_{i,j} = 0.0$

These boundary conditions are updated prior to each calculation.

### 5.3 Open Landward Boundary

The specification of boundary conditions for open inflow/outflow boundaries is a difficult task. Examining the form of the finite difference approximations to the convection terms, it is discovered that inflow/outflow velocities can be handled best through upwind differencing. Unfortunately, the scheme used for solving the numerical model does not lend itself readily to upwind differencing. However, to include the fresh water flows it is necessary to use the upwind method, and the numerical model has been changed accordingly.

In the current study of San Pablo Bay, there is an inflow boundary near Crockett, California, which obviously impacts heavily on the transport of material. With a two-dimensional model it is impossible to simulate this influence without including a special boundary condition. In this instance the velocity was specified as a function of the flow and the lagged tide. This boundary condition was developed because under flood tide conditions there is a long saline wedge extending up into the fresh water source which cannot be accounted for in the two-dimensional model. Consequently, the following boundary conditions are prescribed at an open landward boundary (Figure 5.2):



$\xi_{i-1}, \xi_i, \xi_{i+1}, \xi_{i+2}$  are calculated

$U_{i-1}, U_i, U_{i+1}, U_{i+2}$  are specified

FIGURE 5.2 OPEN LANDWARD BOUNDARY

$$\frac{\partial \xi}{\partial x} = 0.0; \quad \xi_{j+1} = \xi_j$$

$$U_{j(\text{last})} = \frac{U_{(\text{in})}}{(h+\xi)_{(\text{in})}} - f(\text{tide})$$

$$f(\text{tide}) = 1 - \exp\left(-\left(\frac{\lambda}{u}\right) * (\text{tidemax} - \text{delaytide})\right)$$

$$V_{i,j(\text{last})} = 0.0 \text{ (parallel flow)}$$

#### 5.4 Dry Adjacent Cells

A dry normal cell is shown in Fig. 5.3. In this case, it is reasonable to assume that the velocity ( $U_{i-1,j}$ ) at the cell edge can be calculated by assuming  $\frac{\partial^2 U}{\partial x^2} = 0.0$ . Then, when calculating the new surface elevation, the following boundary conditions can be applied:

$$V_{i,j-1} = -V_{i,j}; \quad V_{i-1,j-1} = -V_{i-1,j}$$

$$U_{i,j-1} = 2U_{i,j} - U_{i,j+1}$$

$$\alpha_{i,j-1} = 2\alpha_{i,j} - \alpha_{i,j+1} \text{ where } \alpha = (\xi, S, C) \quad .$$

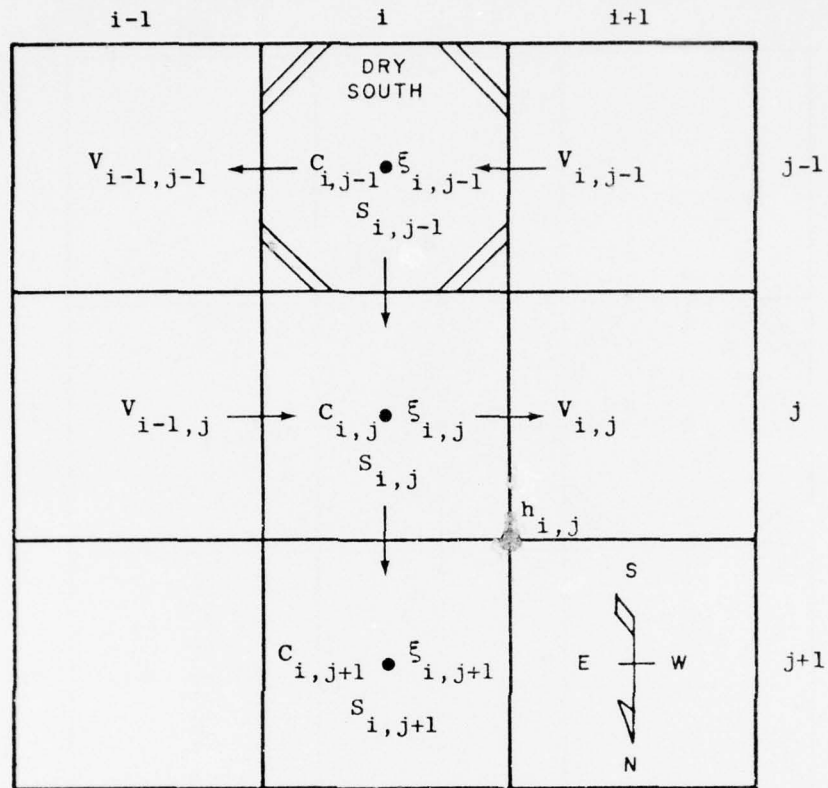
These boundary conditions are required only for the implicit step.

A dry tangential cell is shown in Fig. 5.4. Here the boundary conditions are required in each step and are assumed to be:

$$V_{i-1,j} = 0$$

$$U_{i-1,j-1} = -U_{i,j-1}; \quad U_{i-1,j} = -U_{i,j}$$

$$\alpha_{i-1,j} = 2\alpha_{i,j} - \alpha_{i+1,j} \text{ where } \alpha = (\xi, S, C) \quad .$$



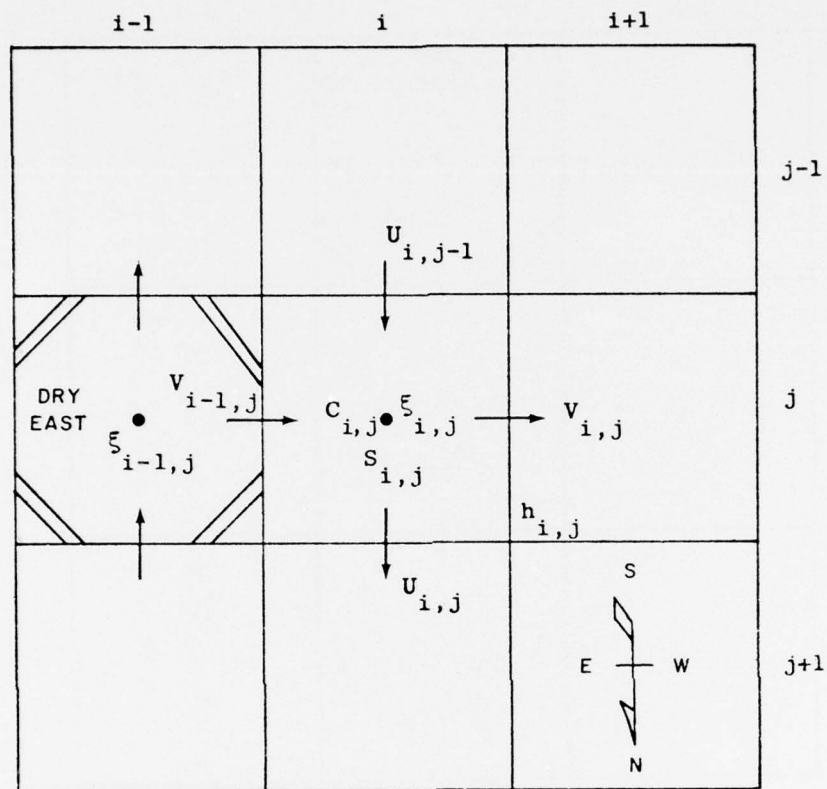
$$V_{i,j-1} = -V_{i,j}$$

$$V_{i-1,j-1} = -V_{i-1,j}$$

$$U_{i,j-1} = 2.0 U_{i,j} - U_{i,j+1}$$

$$(\xi_{i,j-1}, C_{i,j-1}, S_{i,j-1}) = 2(\xi_{i,j}, C_{i,j}, S_{i,j}) - (\xi_{i,j+1}, C_{i,j+1}, S_{i,j+1})$$

FIGURE 5.3 DRY NORMAL CELL



$$V_{i-1,j} = 0$$

$$U_{i-1,j-1} = -U_{i,j-1}$$

$$U_{i-1,j} = -U_{i,j}$$

$$(\xi_{i-1,j}, S_{i-1,j}, C_{i-1,j}) = 2(\xi_{i,j}, S_{i,j}, C_{i,j}) - (\xi_{i+1,j}, S_{i+1,j}, C_{i+1,j})$$

FIGURE 5.4 DRY TANGENTIAL CELL

### 5.5 Top and Bottom Boundaries

The top and bottom boundary conditions are included directly into the integrated equations of motion. These conditions are given by:

$$T_{bx} = \frac{\rho g U q}{C^2} ; \frac{T_{wx}}{\rho_w} = \frac{\rho_a}{\rho_w} C_D W_x q_w$$

$$T_{by} = \frac{\rho g V q}{C^2} ; \frac{T_{wy}}{\rho_w} = \frac{\rho_a}{\rho_w} C_D W_y q_w$$

where  $q = (U^2 + V^2)^{1/2}$ ,  $q_w = (W_x^2 + W_y^2)^{1/2}$  and  $C_D$  is a surface drag coefficient  $\cong 1.3 \times 10^{-3}$ . These boundary conditions appear directly in the vertically integrated equations of motion [Eq. (3.6), (3.7)]. The Chezy coefficient,  $C$ , is a function of the water depth which is initially calculated. Later it can be changed in each cell in the verification phase. A temporally and spatially variable wind field is allowed, although the use of a spatially variant wind on such a small study area is questionable.

## VI RESULTS AND EXPERIMENTATION

### 6.1 Introduction

Basically there are two major areas of interest in this study, although the final objective is to estimate the transport and diffusion of the dredged materials. Initially, the velocity field which will be responsible for the movement of the material must either be specified or calculated. Then, using this velocity field, the transport and deposition of the dredged material can be determined.

### 6.2 Velocity Field

Verification of the type of transport model as used in this study has been done by Leendersse,<sup>4</sup> Simons,<sup>5</sup> etc., and it is apparent that the model would indeed simulate a particular outcome within reasonable limits. However, the current study requires a model that would produce reasonable velocity fields for several different periods of time. Therefore a "classical verification" may be misleading as the verification would be good for only the particular set of data used in the verification. Conversely, the argument could be advanced that without this verification, the results of the tracer simulation are meaningless. However, if the model is qualitatively reasonable then the mass transport of the dredged material should also be qualitatively correct. This implies that it should be possible to identify those areas of the Bay where the dredged material has been transported, although it is not possible to make definitive judgements about the amount transported, deposited, and subsequently resuspended. The approach in this study is to analyze the results of each run to determine if these conform to observed values. The final results of the hydrodynamics simulation will be given with the tracer simulation.

Stability of the numerical model is unclear at the present time due to the necessity to use upwind differencing to account for the large fresh water inflows. It is possible that the Courant condition ( $\Delta t \leq \Delta X/Cg$ ) may become a factor in the calculation because the implicit scheme has been changed. Numerical testing will be used to determine the stability requirements of the model.

### 6.3 Initial Simulation

The appropriate mathematical models governing the movement of a single particle in free fall in a moving liquid were presented in Section 3.2.4. Given the particle density and equivalent spherical size, and given a time-history of the hydrodynamics of the water body, it should be possible to estimate the movement of the particle. The current model does not consider local turbulence, interparticle forces, the influence of surrounding dumped particles, the salinity and stratification present, nor the prevailing estuary conditions at the time of dumping.

As a general rule, the typical size of non-dispersed particles found in the dredged material of Mare Island Strait is of the order of 20 $\mu$  (microns =  $1 \times 10^{-6}$  meters) (Leahy<sup>7</sup>). Consequently, the tracer particles used in this study are of this size. According to existing theory (Graf<sup>2</sup>), and using an iterative technique, the values for  $W_{pt}$ ,  $C_D$  and  $R_e$  (terminal velocity, drag coefficient and particle Reynolds number) are, respectively, 0.2 cm/sec, 43.0, and 0.6. The time required to reach the terminal velocity is less than one second.

The implications in the above analysis play an important role in the analysis. First, because the time steps are of several hundred seconds, the particles can be thought of as always having achieved their terminal velocity. Hence, solution of equation (3.13) is unnecessary. Second, because it was assumed that the vertical velocities were negligible,

there is no vertical force to resist the fall of these particles through the water column. Consequently, unless a correction factor is applied, the particles will always travel along the bottom. Third, if a resuspension parameter based on local turbulence is introduced, almost any disturbance will be able to resuspend the particles as there is no allowance for flocculation or interparticle forces once the particles settle. Fourth, because the estuary is assumed to be well mixed, there is no vertical salinity gradient to change the falling action of the particle. All of these restrictions will influence the simulation of the tracers' movements.

To increase the usability of the model the mean concentration of the dumped dredged material is also simulated. No attempt is made to simulate the actual sediment loading in the estuary. Rather, the disposed material was treated as a separate substance and was simulated for convection and diffusion as given by equation (4.8). This mean concentration simulation gives an indication of probable areas of dredged material movement.

The movement of a tracer and the concentration contours for dredged material dumped on the incoming tide are shown in Figures 6.1(a) through (e). The dump location is  $n=6$ ,  $m=36$ , at the south side of Carquinez Strait, opposite the dredge disposal site. The contours in Figure 6.1 are normalized, and each contour decreases by  $1/2 \log_{10} (10^{-1})$ . Notice that the single tracer particle is convected up into the fresh water channel (Fig. 6.1d) and does not move into Mare Island Strait. However the mean concentration simulation shows that there is a large transport of material back into the Strait with a large pocket of material being formed half way up the channel. Then, after the tide reverses, the particle actually is transported back into San Pablo Bay and the concentration in Mare Island Strait decreases (Fig. 6.1e) due to the dilution caused by the inflow of the Napa River. In actual fact, the dredged

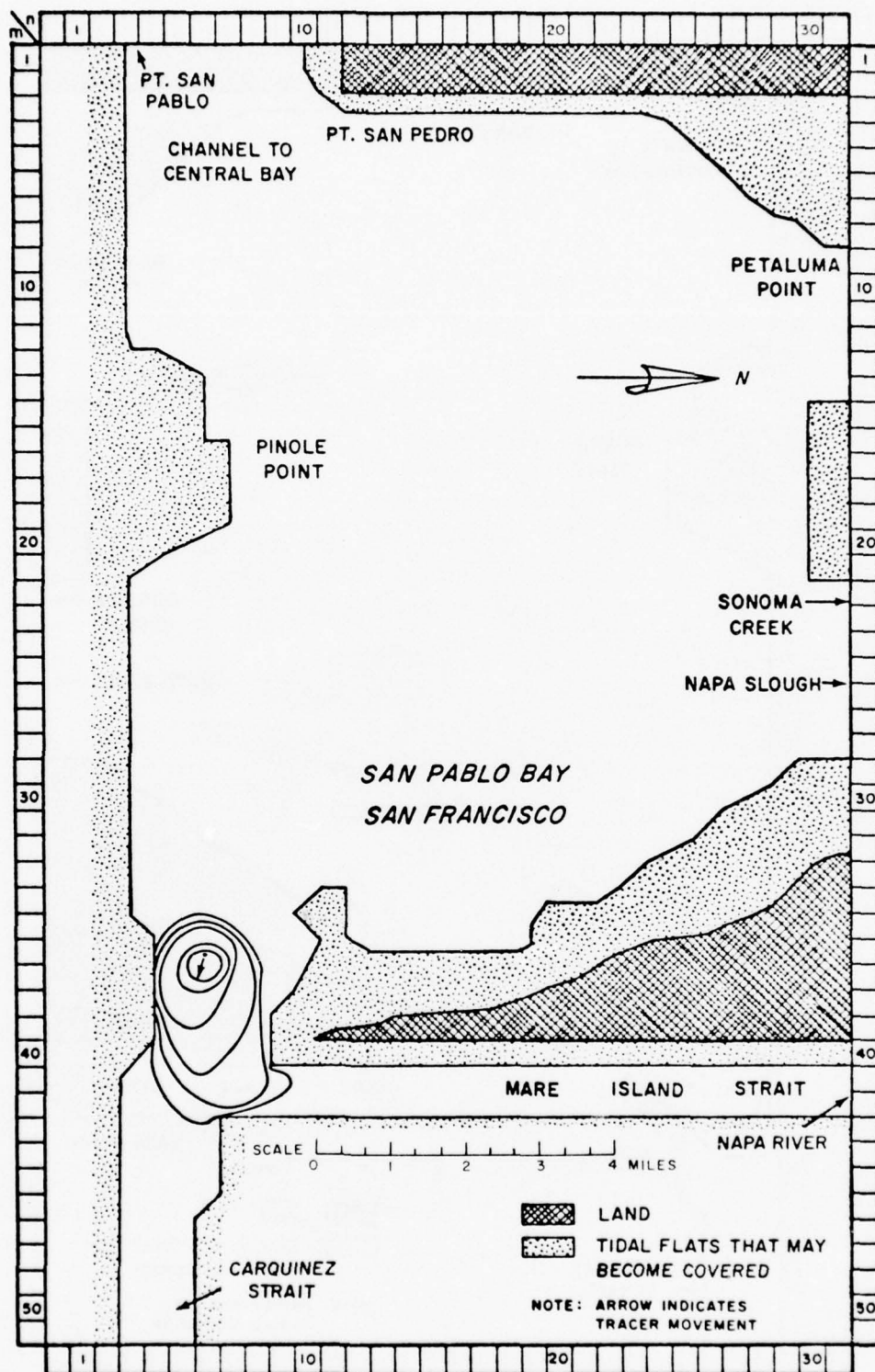


FIGURE 6.1a DREDGED MATERIAL CONCENTRATION AND MOVEMENT.  
TIME = 4500 SECONDS (INCOMING TIDE)

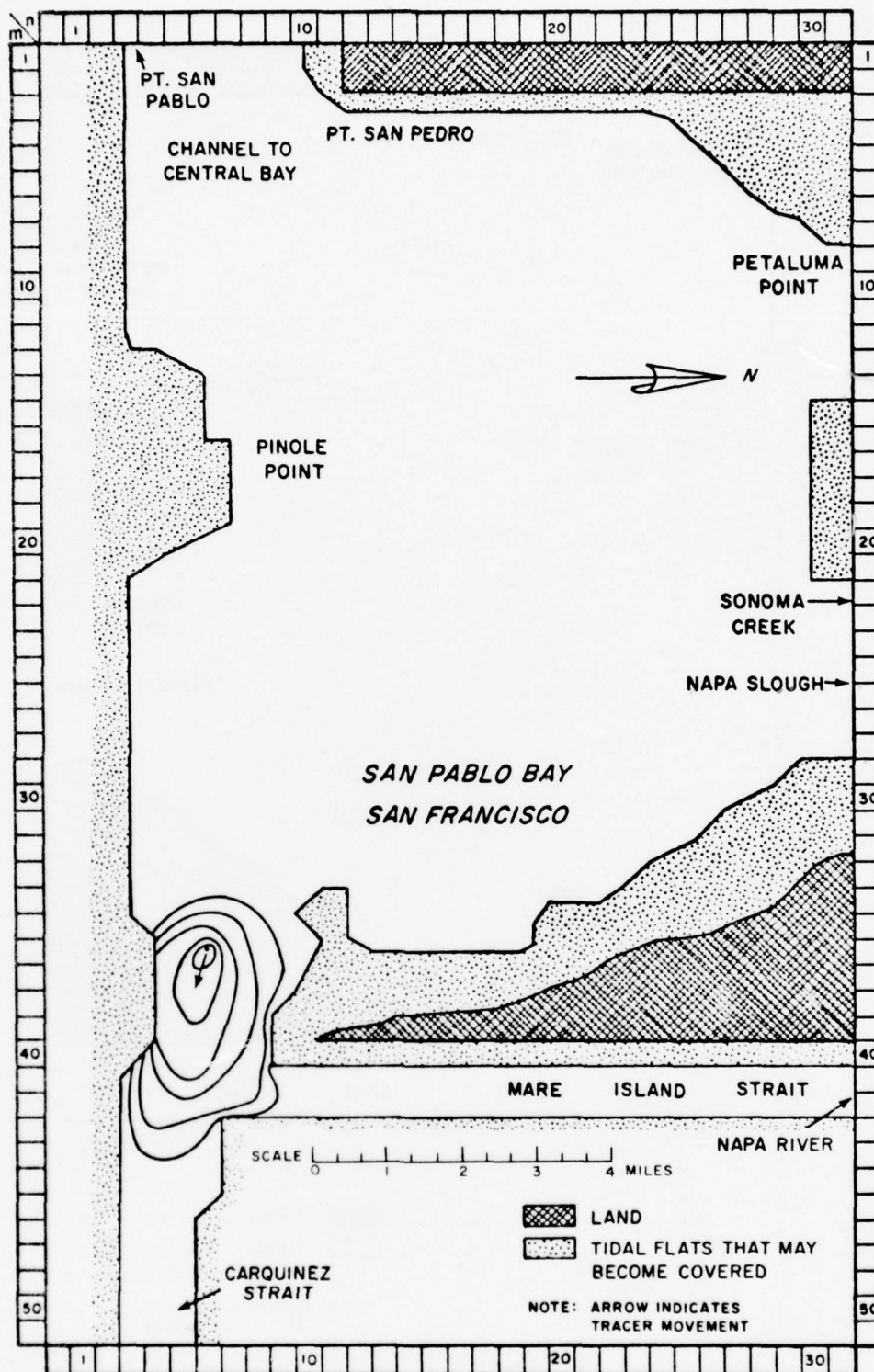


FIGURE 6.1b DREDGED MATERIAL CONCENTRATION AND MOVEMENT.  
TIME = 6150 SECONDS

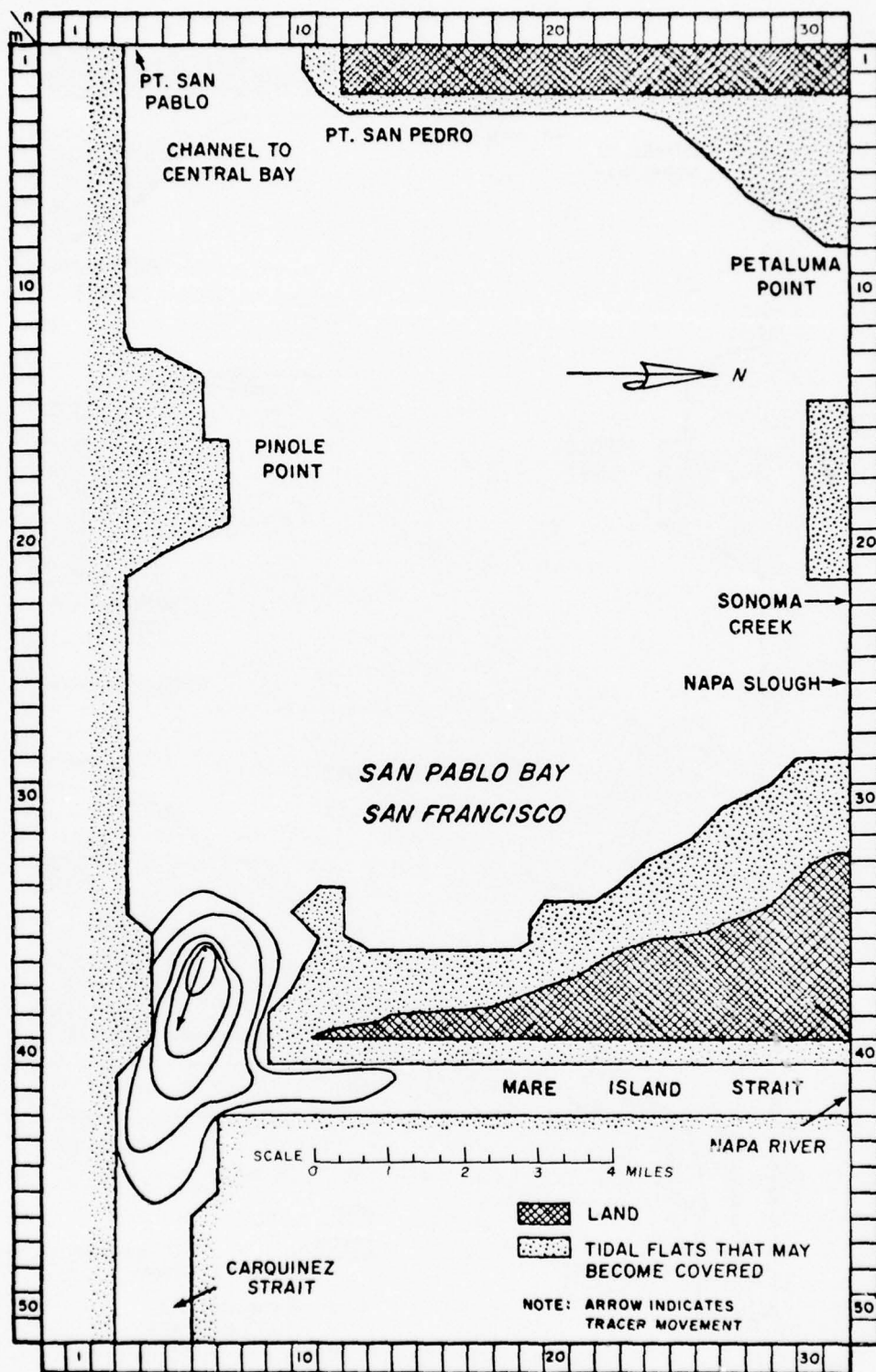
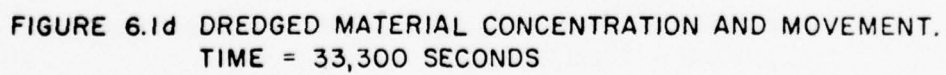


FIGURE 6.1c DREDGED MATERIAL CONCENTRATION AND MOVEMENT.  
TIME = 7500 SECONDS



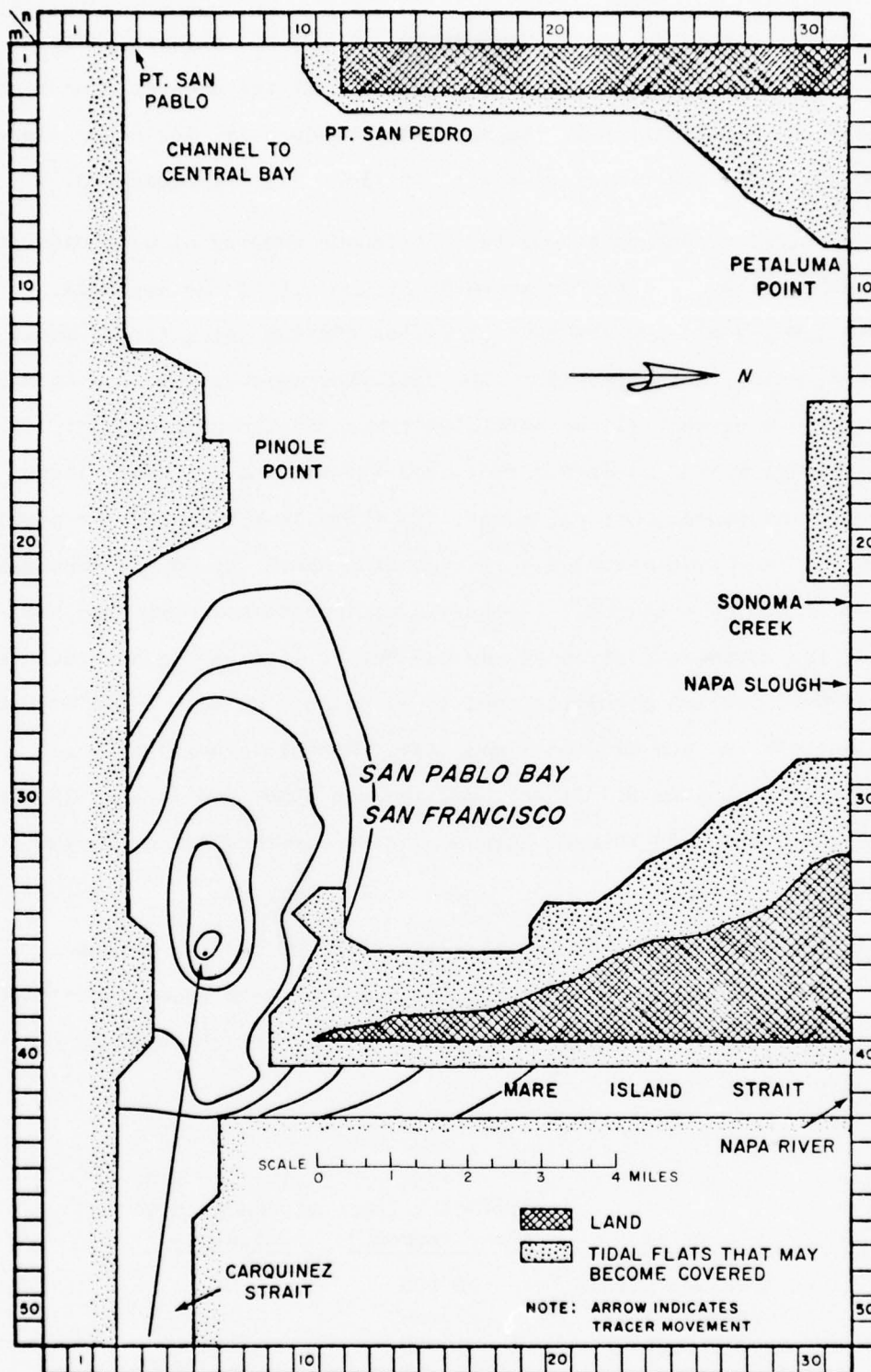


FIGURE 6.1e DREDGED MATERIAL CONCENTRATION AND MOVEMENT.  
TIME = 45,600 SECONDS (APPROACHING LOW TIDE)

material may settle on the bottom and remain there. Unfortunately, there is no way of simulating this phenomenon at the present time because of the two-dimensionality of the model. Subsequently, for other simulation runs only the tracer particle positions will be presented.

The final tracer positions for continuous dumping of particles at (n=8, m=36) after 55 hours is shown in Figure A.2 of the Appendix. Figures A.3 and A.4 are the same plots for dumping sites (n=14, m=14) and (n=5, m=10), respectively. The following observations can be made for all these cases: (1) no particles remain in the main channel, (2) particles which get into Mare Island Strait tend to remain there, even with the two-dimensional model, (3) there is a tendency for particles to go into the Carquinez Strait if they find their way to the southern portion of the main channel, (4) particles tend to move into the shallow area of the northern portion of the Bay rather than moving out into the central Bay, and (5) particles tend to accumulate on both sides of Pinole Point on both the ebb and the flood tide. Channel velocities in all cases reach a maximum 8.1 ft/sec. and average about 2.6 ft/sec. in the main channel which is in good agreement with observed values in the channel.

The tide data for the initial simulation and for the extended particle simulation are shown in Figure 6.2. The wind speed is assumed to be zero, and the fresh water inflow and the time for the tide to reach the inlet are as follows:

<u>Inlet</u>	<u>Inflow Volume (feet<sup>3</sup>/second)</u>	<u>Time for Tide to Reach Inlet (minutes)</u>
Carquinez Strait	10,000	37
Petaluma River	1,000	10
Napa Slough	1,000	15
Napa River	1,000	20

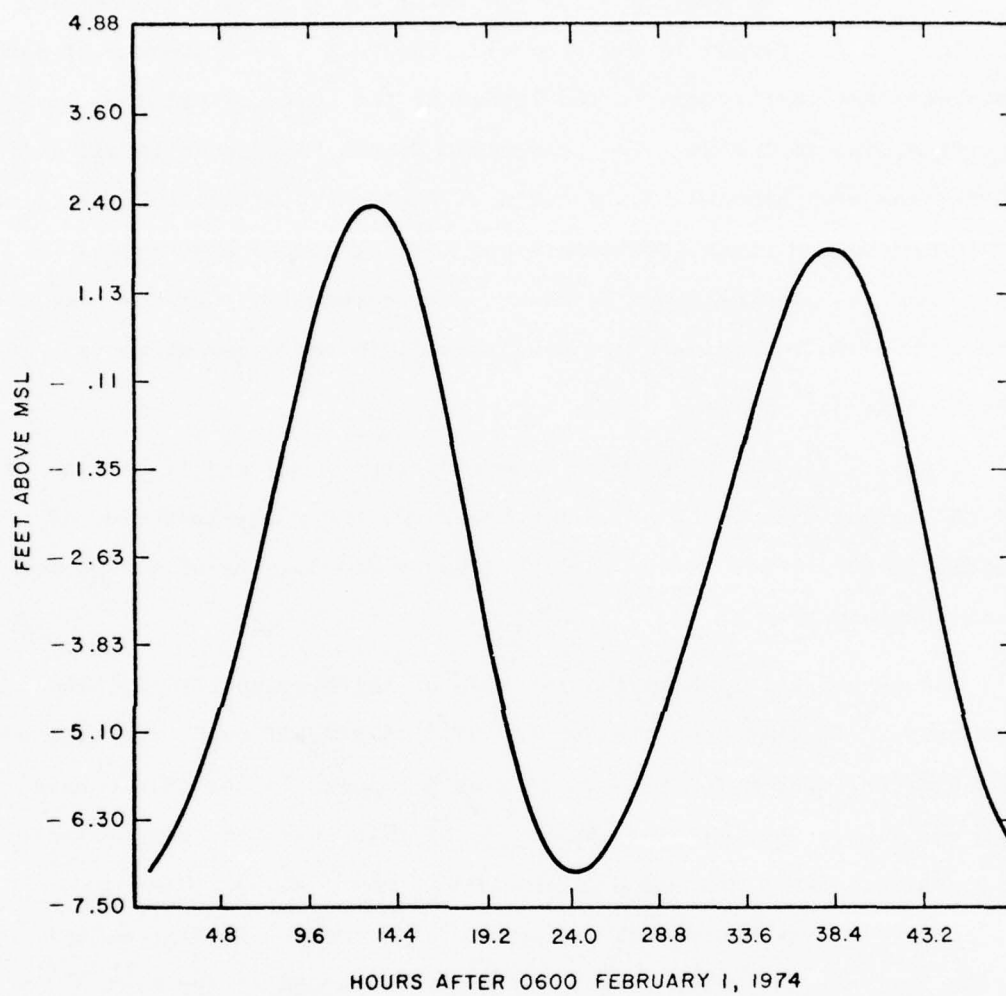


FIGURE 6.2 SIMULATED TIDE LEVEL

#### 6.4 Extended Particle Simulation

To maintain the continuity of the text, the figures discussed in this section are placed in the Appendix. Figure A.1 is a diagram of San Pablo Bay that corresponds to the layout of the computer printout in Figures A.2(a) to A.2(d). The prescribed depths being used in all the simulations are shown in Figure A.2(a). Figure A.2(b) is the calculated surface elevation after 1000 time steps (111.11 hours) and Figures A.2(c) and (d) are the V and U velocity map respectively at the same time. These four figures apply equally well to the cases shown in Figures A.3, A.4 and A.5.

Figure A.2(e) is a computer generated tracer map and is similar to all the tracer maps to be presented here. On the right-hand side of the map is the tracer number and its x and y coordinates as calculated in the DREGSIM program.

The asterisk (\*) marks the location of the dumping site for the simulation. In this case the dumping site is  $n=8$  and  $m=36$ , corresponding to the dredge disposal site. Tracers with numbers larger than 6 have been positioned initially at the center of this cell; one new particle is deposited every two hours of simulation time. Hence, these particles give a time history of the particle movement. In Fig. A.2(e) we see that new particles 7, 8 and 9 have been added to the system (particle number 7 is hidden by the asterisk marking the dumping site). Particles 1-6 were initially positioned in the Bay as follows:

- 1  $n=5, m=3$
- 2  $n=13, m=10$
- 3  $n=6, m=21$
- 4  $n=4, m=50$
- 5  $n=13, m=31$
- 6  $n=7, m=37$ .

The positioning of these first six particles is the same in all runs in this report. They act as a test to determine that the model and data are consistent between tests. The hydrodynamic calculation is the same for each test case, so that valid comparisons can be made between the tests.

Continuing through the sequence of figures in Fig. A.2 we see that the tendency is for the particles to move up into Mare Island Strait as the tide comes in. Notice in Fig. A.2(f) the distance that particle 7 has moved into the channel. Note also, that particle 7 is always dumped on the incoming tide in all these tests. In Fig. A.2(g) the tide has changed and the particles being dumped are convected west (toward Point San Pablo). However, the particles in the channel have not been influenced very much at this time. The final four figures (Figs. A.2(k), (l), (m) and (n)) show how the particles tend to remain in the vicinity of the dumping site on ebb tide and are pushed up into Mare Island Strait on the flood tide. Also, particles 4, 6, 14, 26 and 38 have actually been convected up into Carquinez Strait. There is no provision in the model to let the particles go outside the study area. Hence when they reach a boundary they remain there until a velocity is developed which can resuspend and convect them back into the main body of water. Finally note the location of the particles in Fig. A.2(j). This figure corresponds to one-half the simulation time and will be used for comparative purposes.

The tracer maps given in Figs. A.3(a) through A.3(f) are similar to those described above (Fig. A.2) except that the dumping site has been moved to (n=14, m=14), as shown by the asterisk in each figure. Particularly notice that the tracer particles do not remain in the vicinity of the dumping site. On the contrary, in Fig. A.3(a) it can be seen that particles have moved to the entrance to the central Bay and the area of the Napa Slough. In Fig. A.3(b) the tracers have actually moved to most areas of the Bay. Notice that a large number of particles have appeared

to cross the main channel to settle in the Pinole Point area. This is significant as all the particles in Fig. A.2(j) have remained on the northern side of the main channel. In the final four frames of Fig. A.3, the particles have indeed been spread over the entire Bay with no exceptions. Two particles have even found their way into Mare Island Strait.

In Figs. A.4(a) through A.4(f) the dumping site is moved to  $n=5$ ,  $m=10$ , and all other parameters remain the same. In this case there is a great reluctance for the particles to cross the main channel. The influence of Pinole Point is clearly visible in that the particles tend to settle on both sides of the Point. The long line of particles at  $m=11$  are actually all in the vicinity of Pinole Point but due to the problems with printing, they erroneously appear to be spread across the channel. The situation shown in Fig. A.4(f) is more typical and clearly shows that the particles prefer the south side of the Bay in this particular case.

Finally, Figs. A.5(a) through A.5(f) present results for a dumping site located at  $n=6$ ,  $m=36$ . Contrast this case with the case given in Fig. A.2 ( $n=8$ ,  $m=36$ ). In Fig. A.5, it is clear that the tendency is for the particles to move up into Carquinez Strait rather than to move toward the ocean opening. They appear to become trapped by Pinole Point and subsequently move toward the opening in Carquinez Strait.

## VII INTERPRETATION AND CONCLUSIONS

### 7.0 Introduction

The results of any numerical simulation are meaningless unless they are viewed in terms of the inadequacies of the model. Recall that the model is actually two-dimensional, whereas nature is seldom less than three-dimensional. Therefore, the results must be viewed with this deficiency in mind when considering the use of simulation techniques in dredging analysis.

### 7.1 Interpretation

The analysis of the results consider primarily the tracer particle movements rather than the merits of the hydrodynamic simulation or the tracer simulation. There are two interpretations to the so-called dumping site: (a) it is a dumping site, (b) it is a transient particle discriminator. The latter interpretation means that any particle arriving at a point, from whatever source, will subsequently act like a particle that was externally deposited there. Hence, one can make judgments about the entire Bay rather than just the dredging site.

One must be very careful in following particles which have found their way to one of the five continuous water openings in the study area. Clearly, the particles should not stop at these boundaries, but should be convected into them. Indeed, these openings may in reality act like sinks, as is probably the case of Mare Island Strait. In Fig. A.3 the particles are able to cross the main channel because they first move into the opening at Point San Pablo and subsequently are convected along the southern side of the Bay when the tide comes in.

Similarly, the particles that find their way into Carquinez Strait will be unduly retained at the boundary and later moved westward as the tide goes out.

## 7.2 Conclusions

The conclusions discussed below are based on the analysis of results of the study as outlined in this report.

(a) There is a large amount of material moving back into Mare Island Strait from the current dumping site. This conclusion is drawn primarily from the results shown in Figures A.2(e) through (n). In addition, there must be a continuous buildup of material in Mare Island Strait based again upon these same figures.

(b) There is a high probability that marked particles deposited at the current dumping site could be found in significant quantities at the following locations:

- (i) Mare Island Strait
- (ii) Carquinez Strait
- (iii) The southern side of the main channel, especially around Pinole Point
- (iv) The area of the Napa Sloughs
- (v) The mouth of the Petaluma River
- (vi) The entrance to the central Bay.

In addition, the simulation indicates that there is slight to no chance of finding marked particles in the main channel. This conclusion does not apply to particles found in fluff or mud in transit moving through the main channel.

(c) Based on the information about the movement of particles into and out of Carquinez Strait, the conclusion is that a major loading of

Mare Island Strait occurs as a result of sediment coming into the Bay via the Carquinez Strait. This movement is particularly noticeable in Figs. A.3(c) through (f) where particles 35 and 40 convincingly move from the Carquinez Strait directly into and up Mare Island Strait.

(d) Whereas it is possible and probable that marked particles which find their way into the central Bay may be moved back into San Pablo Bay and ultimately into Carquinez Strait, there is no evidence that they will move back into San Pablo Bay and then into the northern portion of San Pablo Bay. Intuitively, one would expect them to move up to the mouths of the fresh water inflows, but our simulations always moved the particles back into the Bay along the southern side of the main channel.

## VIII RECOMMENDATIONS

It is recommended that the San Francisco District of the U.S. Army Corps of Engineers use the DREGSIM model developed in this study, in conjunction with their Iridium tracer study, to determine the validity of using simulation techniques in analyzing dredging operations. It is further recommended that additional experiments with the model use various inflows and winds to see the effect of these parameters on the tracer movement. Experiments should also consider different channel depths and locations to determine the significance of the main channel in the tracer movement.

Additional work is required to include better resuspension mechanisms, to include the third dimension, to include a moveable bottom and to include the effects of the fresh/salt water interface. With these added capabilities, numerical simulation could be an effective tool in analyzing existing dredging operations and in evaluating future dredging plans.

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7. Leahy, E. J., Memorandum No. WESEE-74-21, USAEWES Explosives Excavation Research Laboratory, U.S. Army Corps of Engineers, Livermore, California, 1974.

## APPENDIX

Figure A.1 is a schematic diagram of San Pablo Bay scaled to the computer printouts of Figures A.2(a) to (d). Figure A.2(a) shows the specified depths used in all the simulation cases presented in this report. Figure A.2(b) shows the calculated surface elevation after 1000 time steps (111.11 hours), and Figures A.2(c) and (d) are the V and U velocity map respectively at the same time. These four figures apply equally well to the cases shown in Figures A.3, A.4, and A.5.

The tracer maps shown in Figures A.2(1) to (n) and Figures A.3, A.4, and A.5 are snapshots of the particle distribution at the times indicated. The cell positions of the particles are listed on the right of each figure. Since these figures are snapshots, they do not show particle movement; however, particle movement can be deduced from successive snapshots or from changes in the listings of particle positions. In these snapshots, the print space for each cell can show the presence of only one particle; other particles located in the same cell are shown in adjoining cells in the same row. Therefore, when a snapshot shows several particles occupying consecutive cells in a row, it may indicate a cell with multiple particles. A check of the particle position listing is necessary to verify this situation.

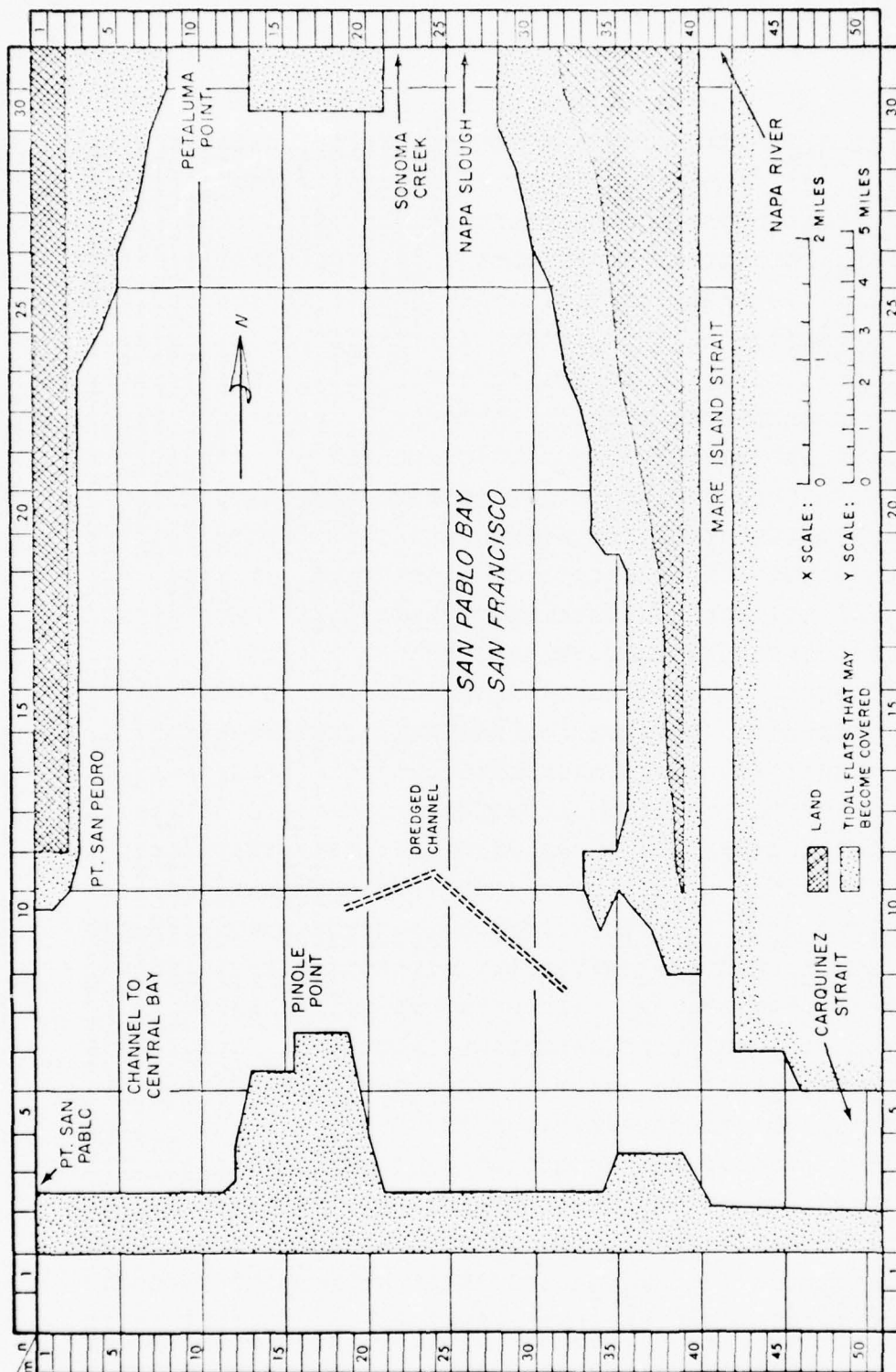
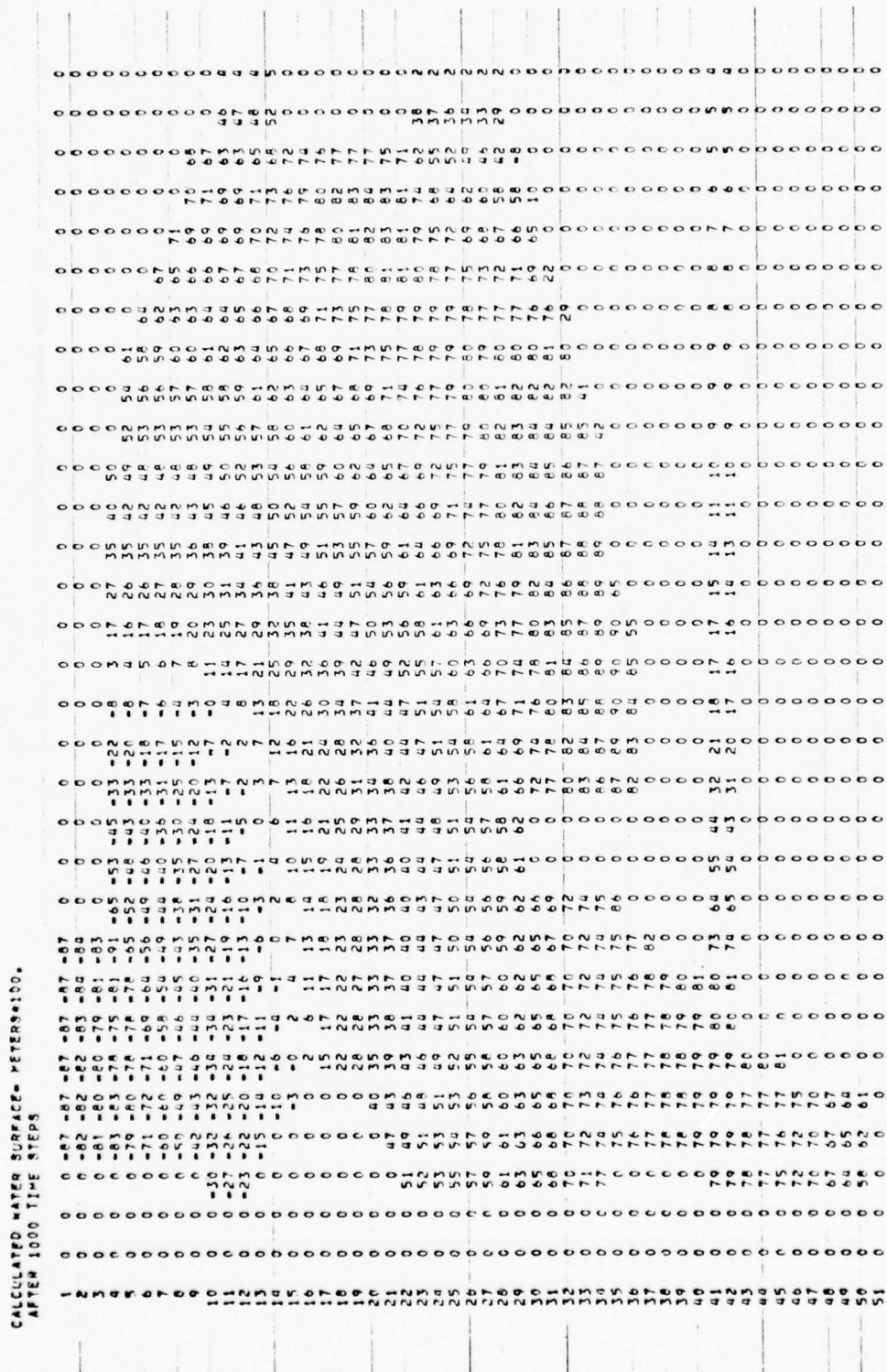


FIGURE A.1 SAN PABLO BAY (Dimensioned to Computer Printout, not to Scale)

[illegible]

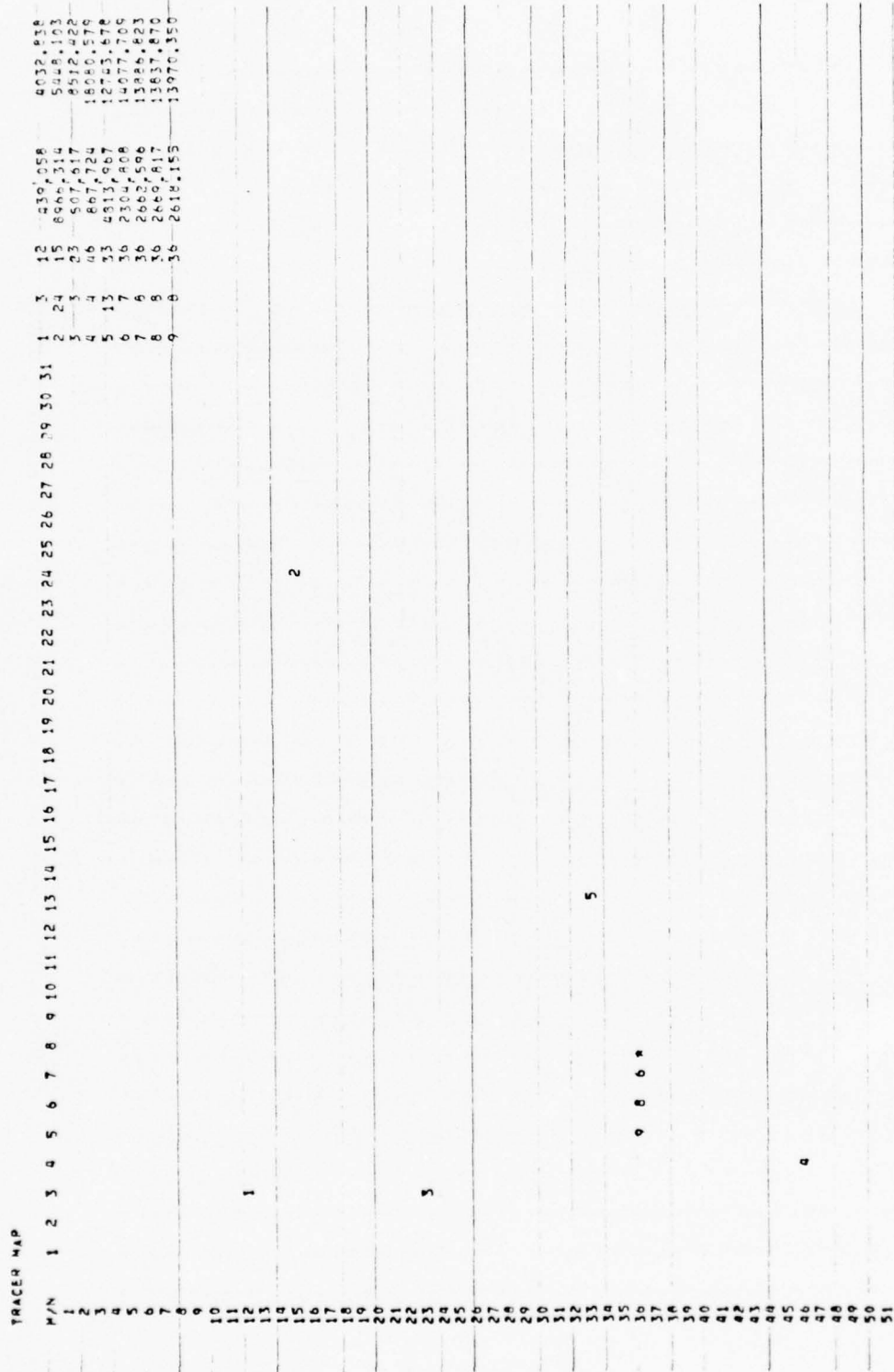
Figure A.2(a) PRESCRIBED ESTUARY DEPTHS--METERS \* 10.0



CALCULATED VELOCITIES-(METERS/SEC)*100. AFTER 1000 TIME SECS		CALCULATED V-VELOCITY (METERS/SECOND) * 100.0 TIME=111.11 HOURS	
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
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8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0
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18	0	0	0
19	0	0	0
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38	0	0	0
39	0	0	0
40	0	0	0
41	0	0	0
42	0	0	0
43	0	0	0
44	0	0	0
45	0	0	0
46	0	0	0
47	0	0	0
48	0	0	0
49	0	0	0
50	0	0	0
51	0	0	0

Figure A.2(c) CALCULATED V-VELOCITY (METERS/SECOND) \* 100.0  
TIME=111.11 HOURS

Figure A.2(d) CALCULATED U-VELOCITY (METERS/SECOND) \* 100.0  
TIME=111.11 HOURS





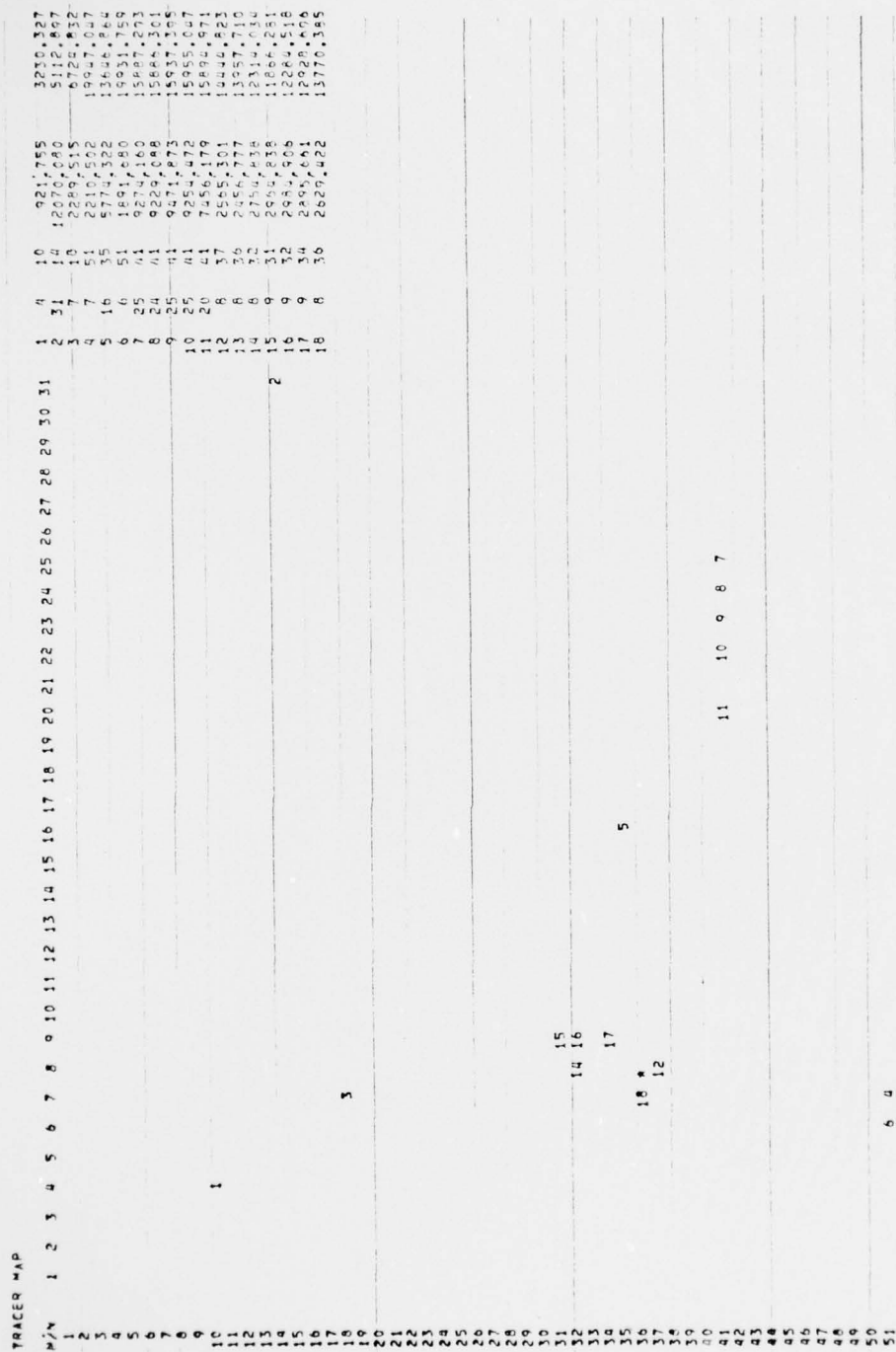


Figure A.2(g) TRACER MAP AT TIME=22.22 HOURS  
(n=8, m=36)

TRACER MAP																																		
M/N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
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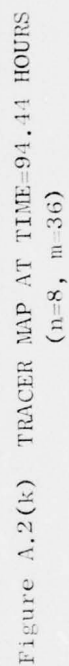
Figure A.2(h) TRACER MAP AT TIME=27.78 HOURS  
(n=8, m=36)



Figure A.2(i) TRACER MAP AT TIME = 33.33 HOURS  
(n=8, m=36)

62

5-69

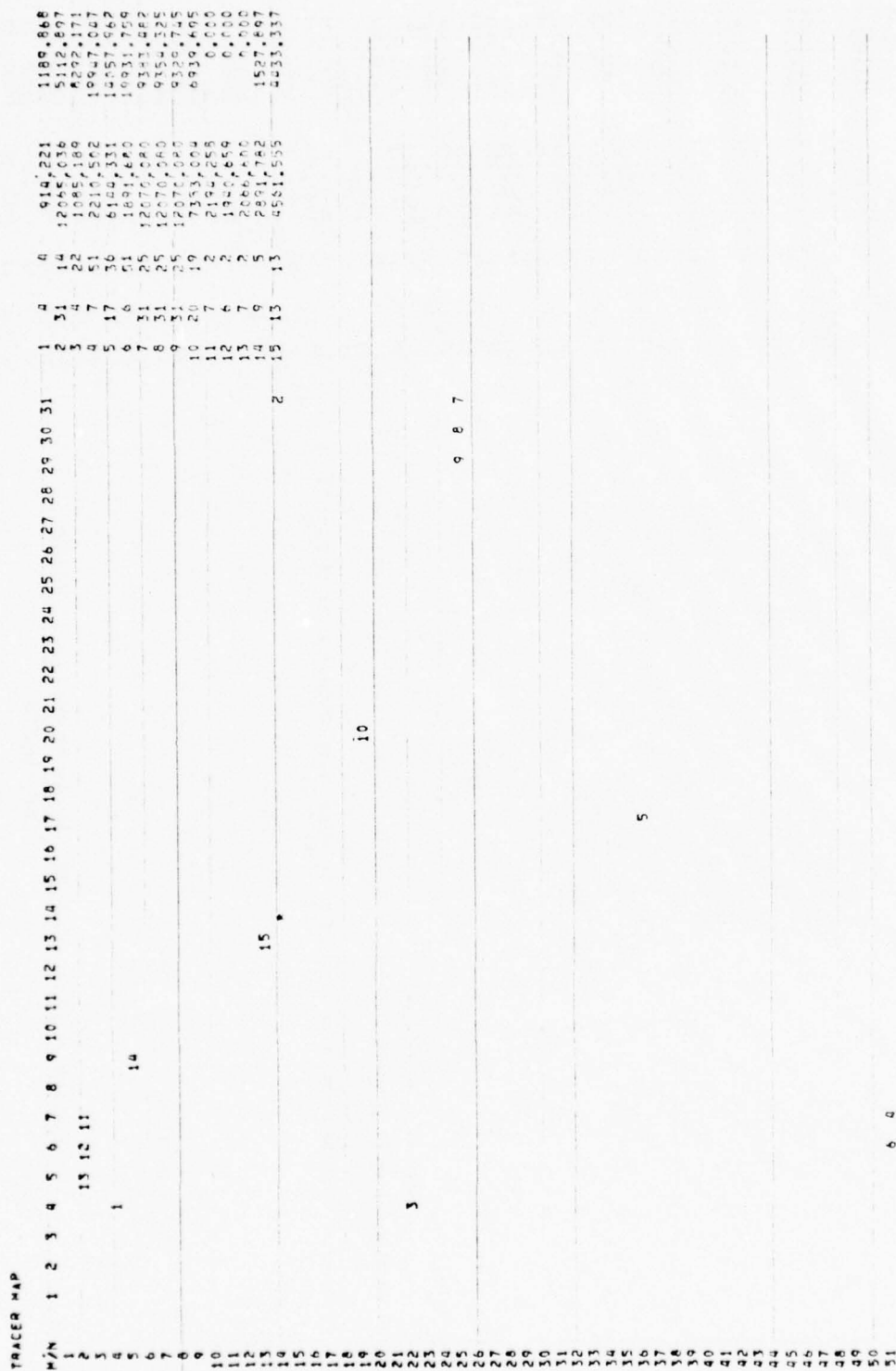


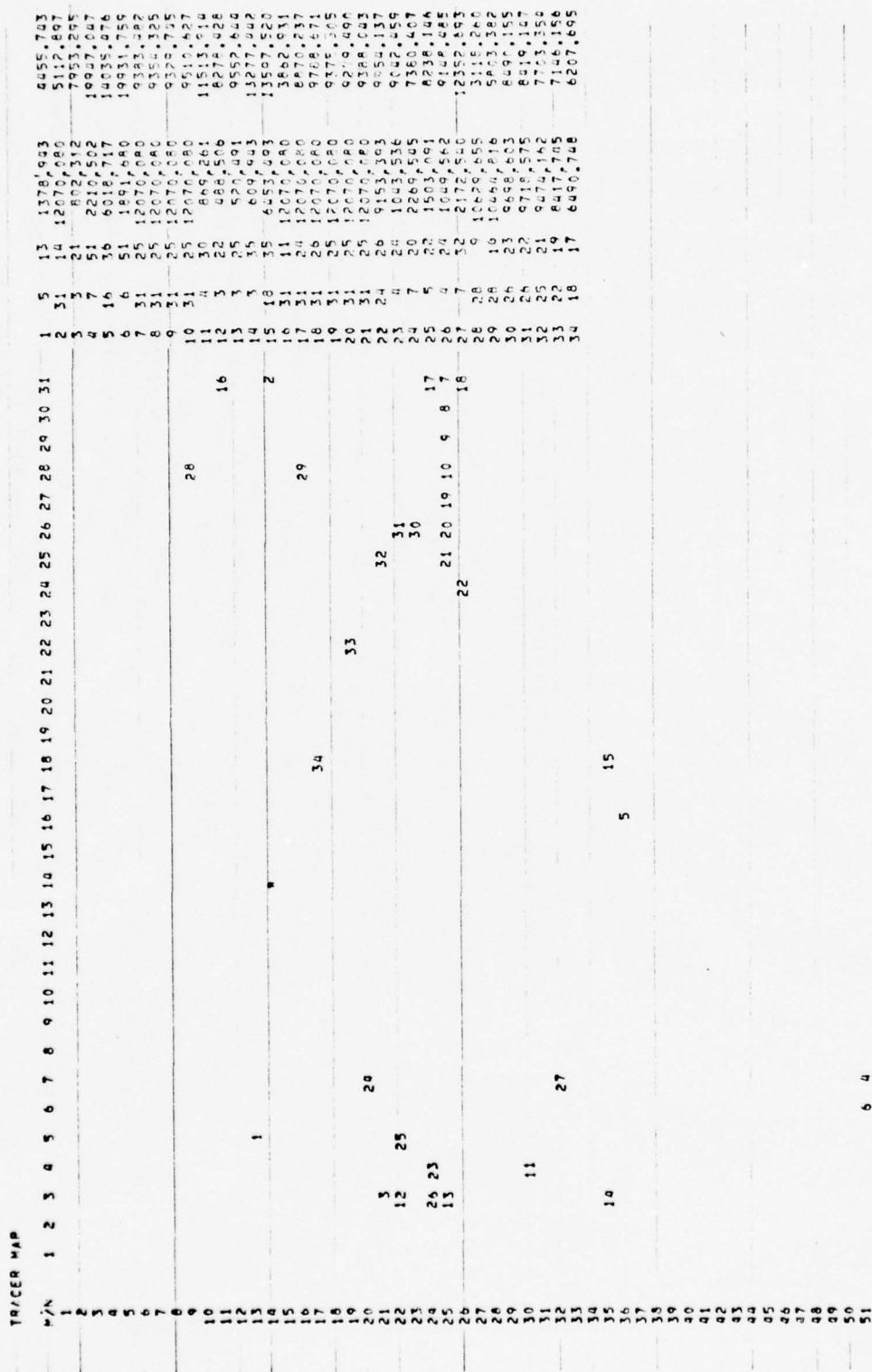
TRACER MAP																																		
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Figure A.2(1) TRACER MAP AT TIME=100.00 HOURS  
(n=8, m=36)





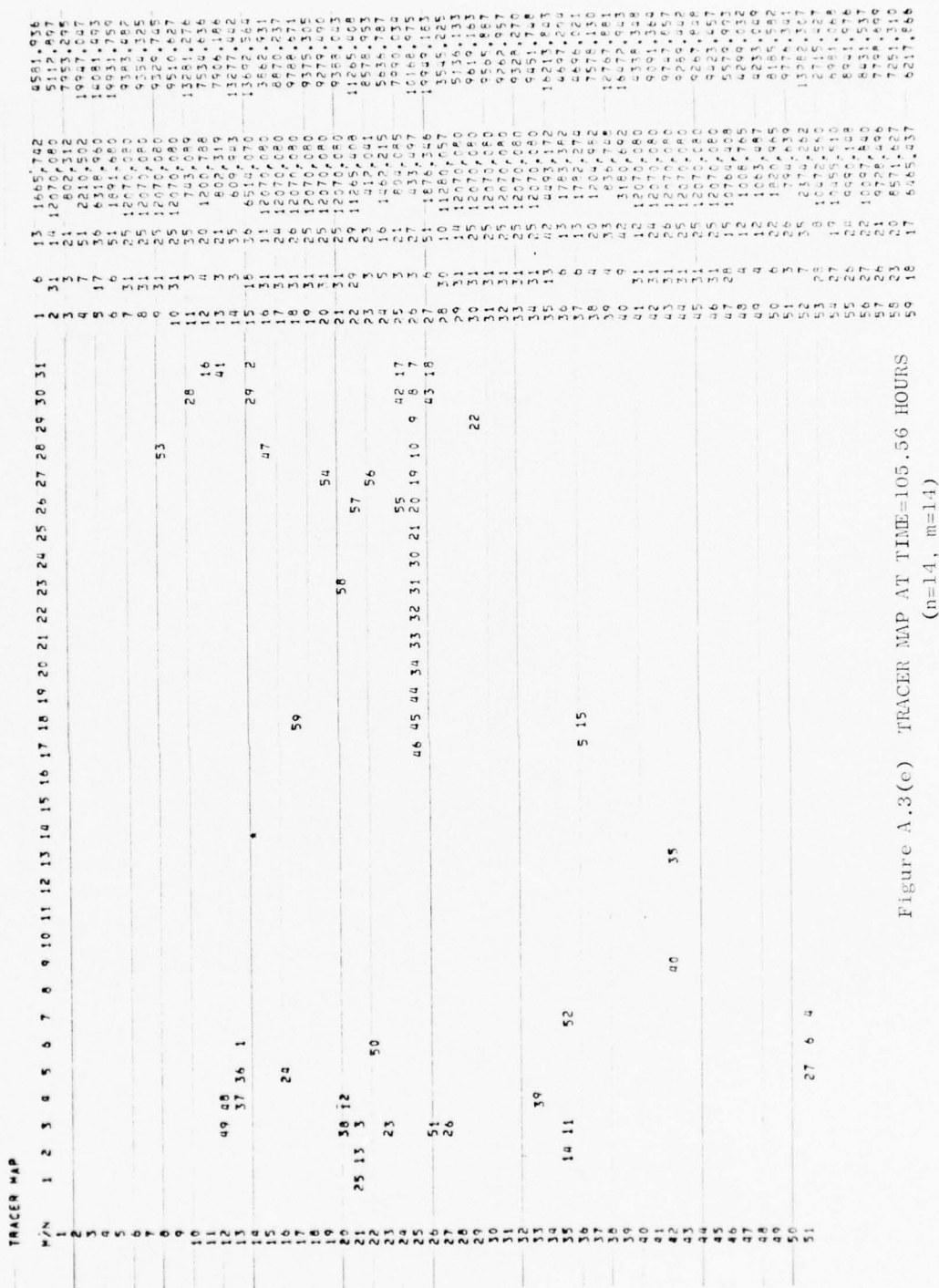


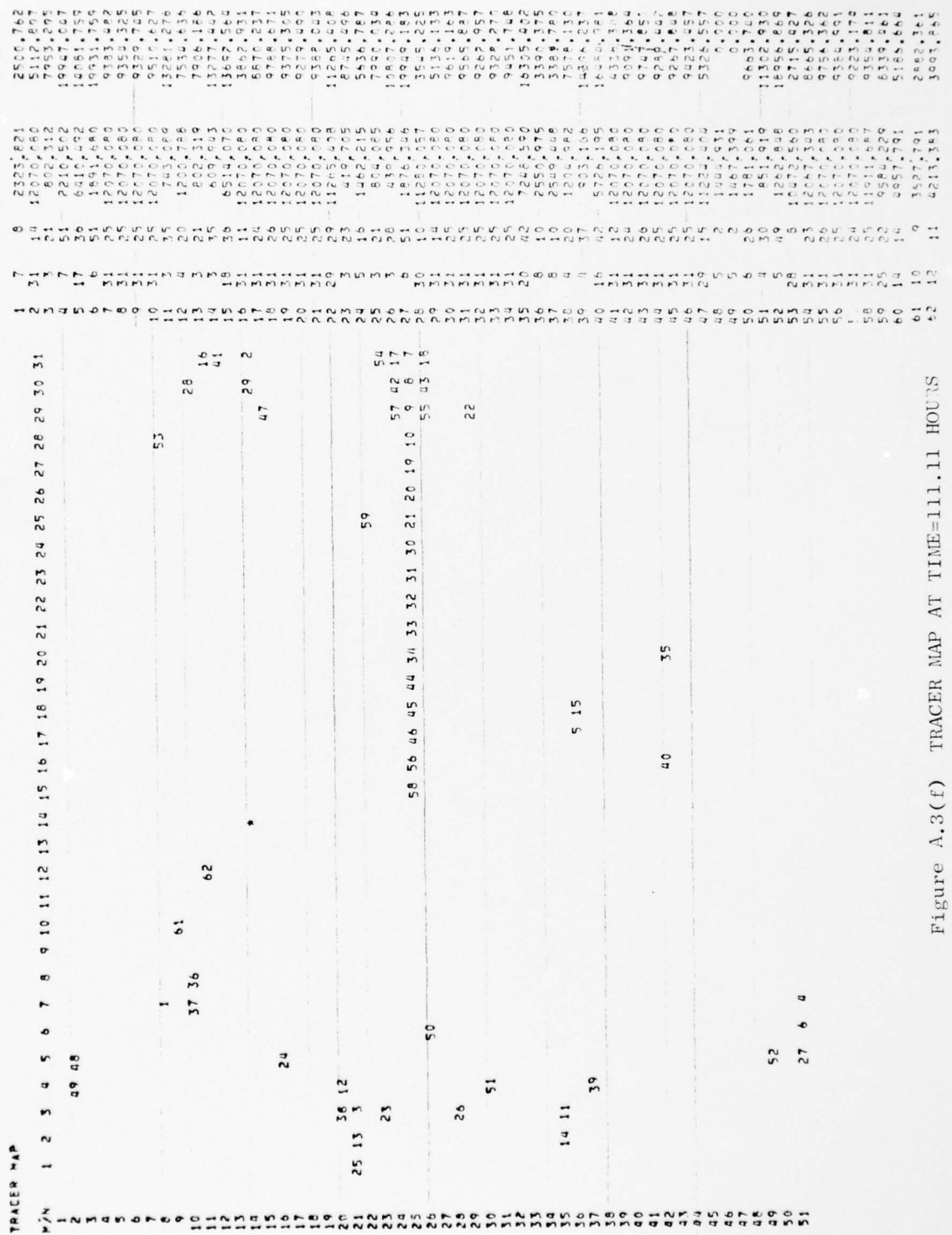


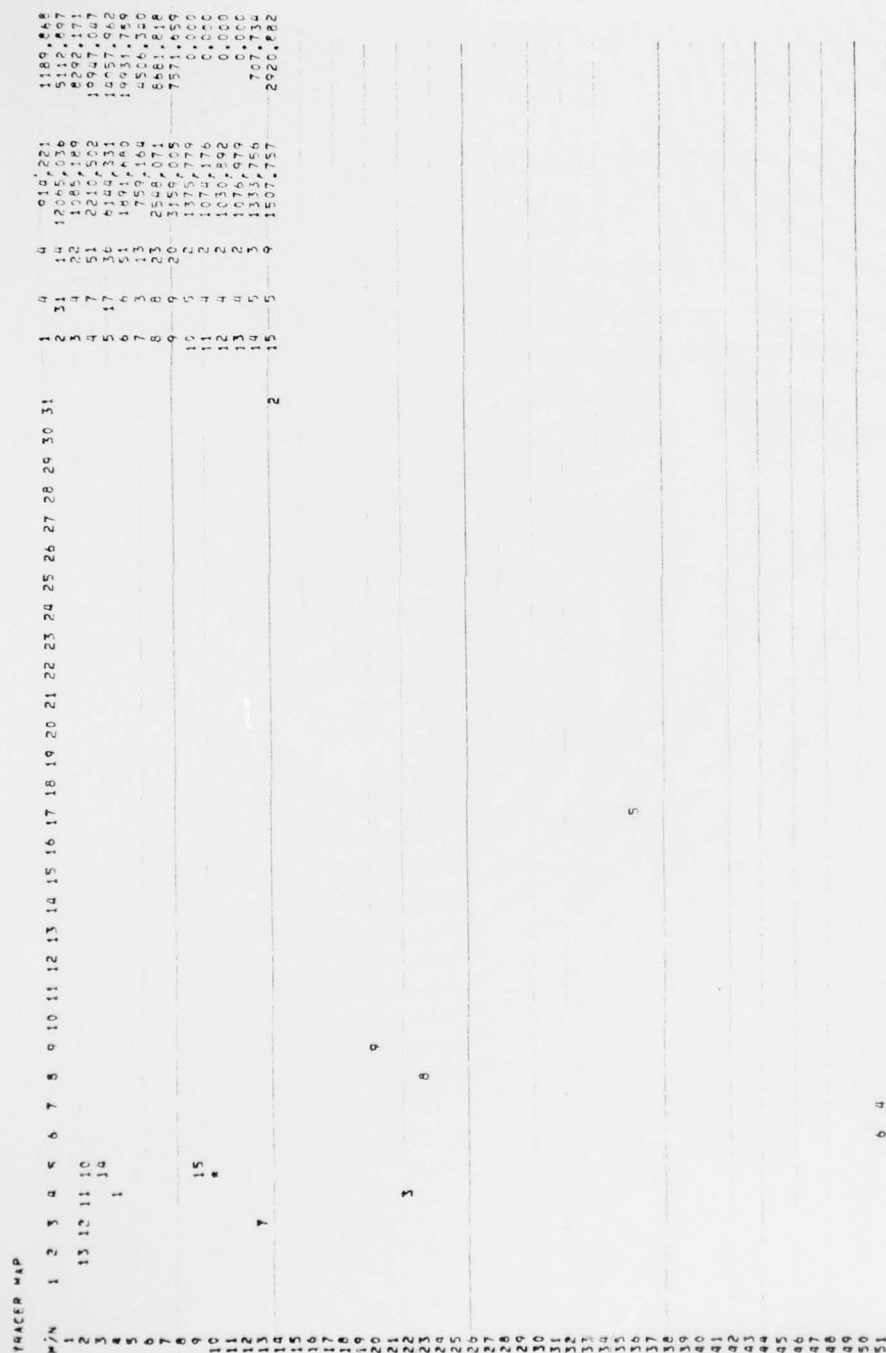
TRACER MAP																															
M/N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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Figure A.3(c) TRACER MAP AT TIME=94.44 HOURS  
(n=14, m=14)









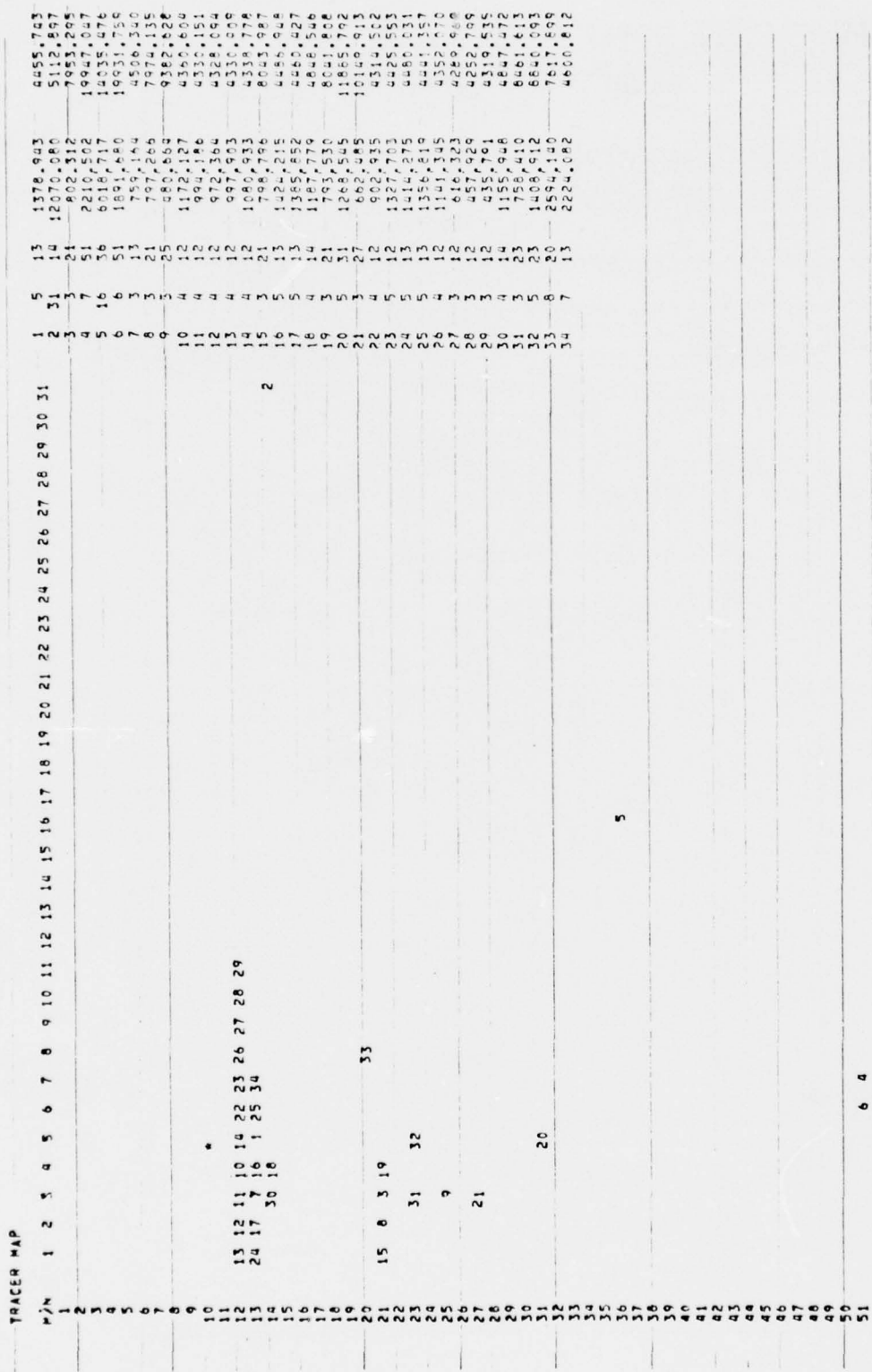
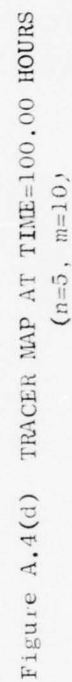


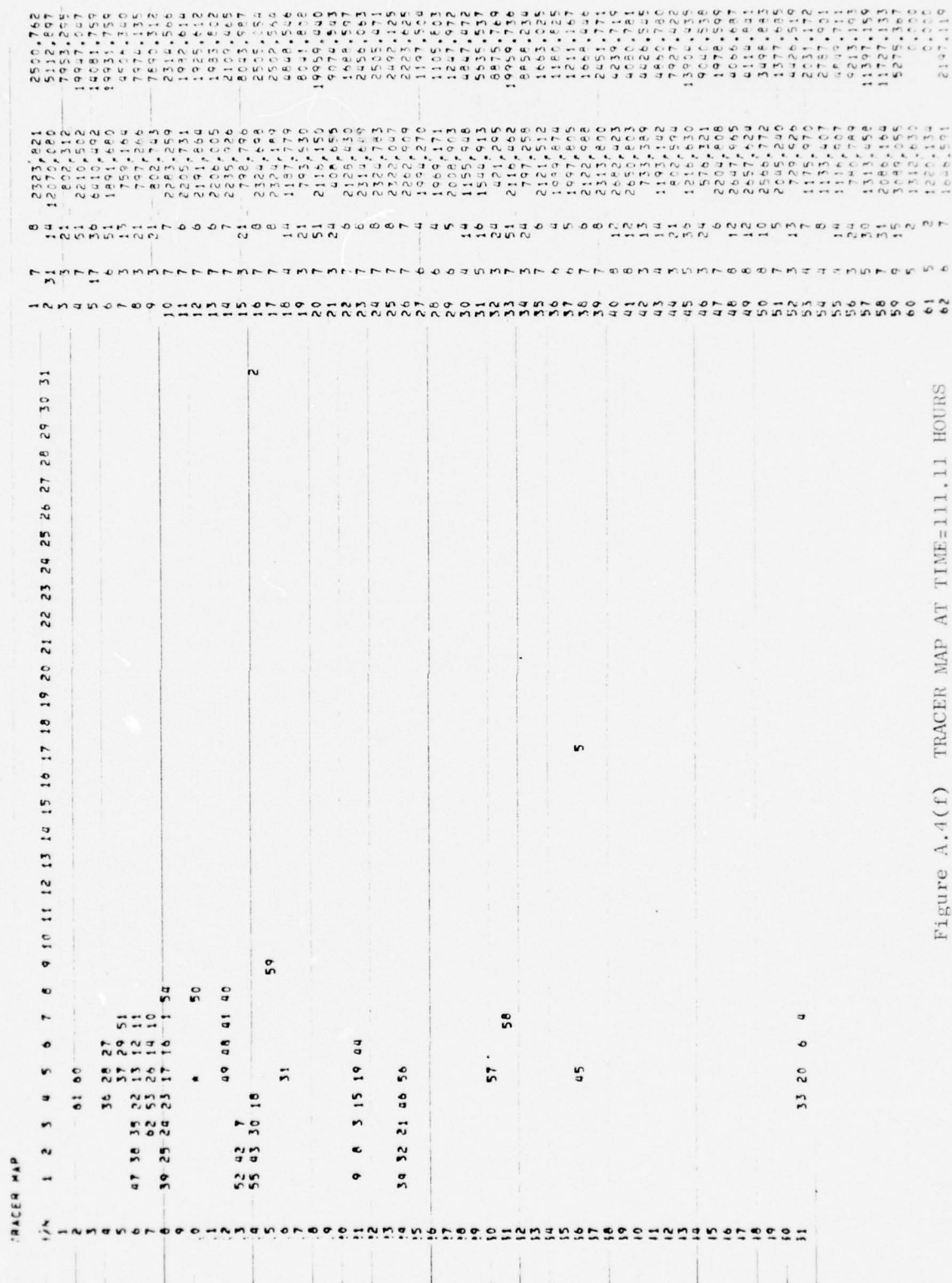
Figure A.4(b) TRACER MAP AT TIME=55.56 HOURS  
(n=5, m=10)

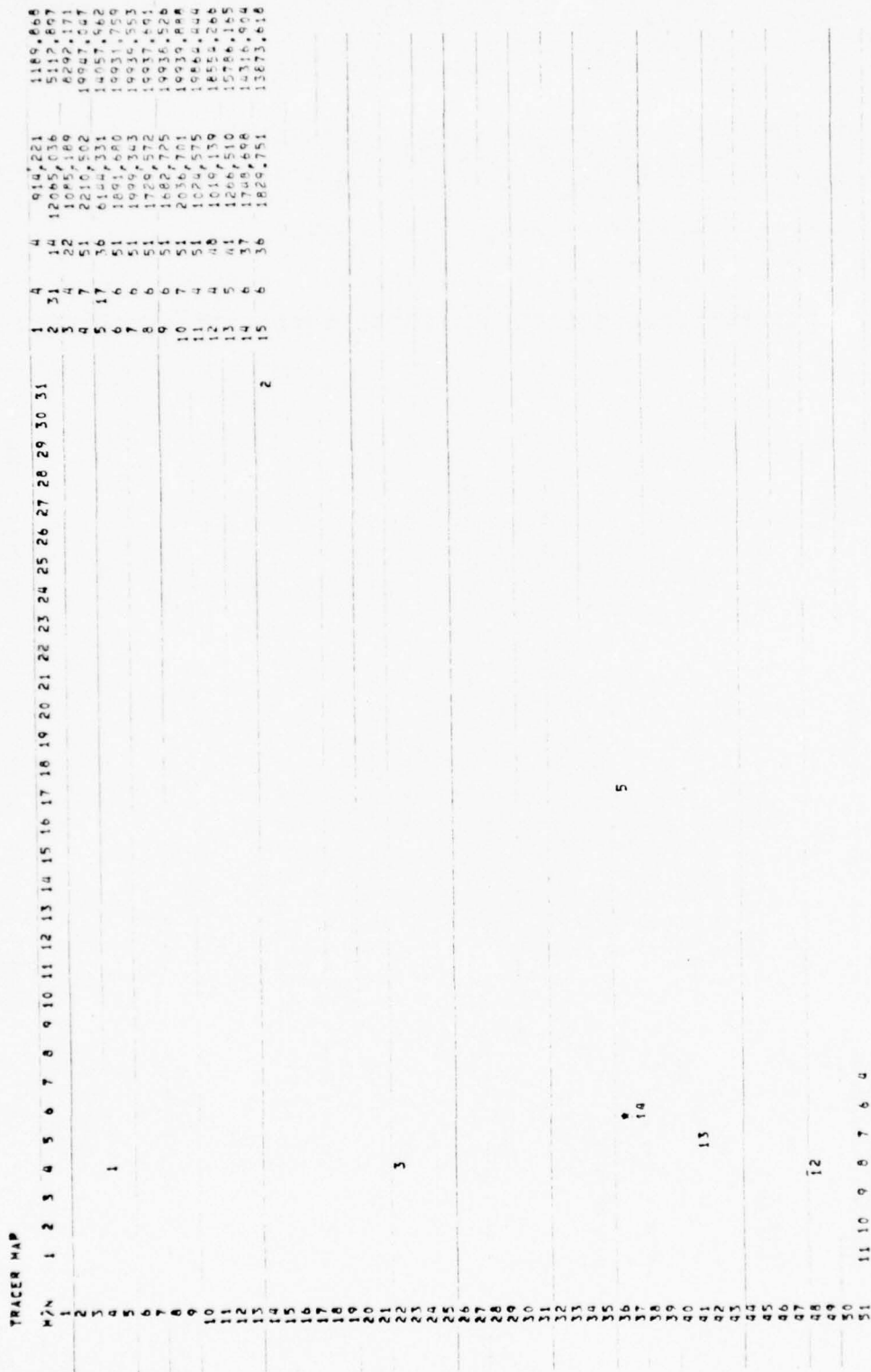




[illegible]

Figure A.4(e) TRACER MAP AT TIME=105.56 HOURS  
(n=5, m=10)





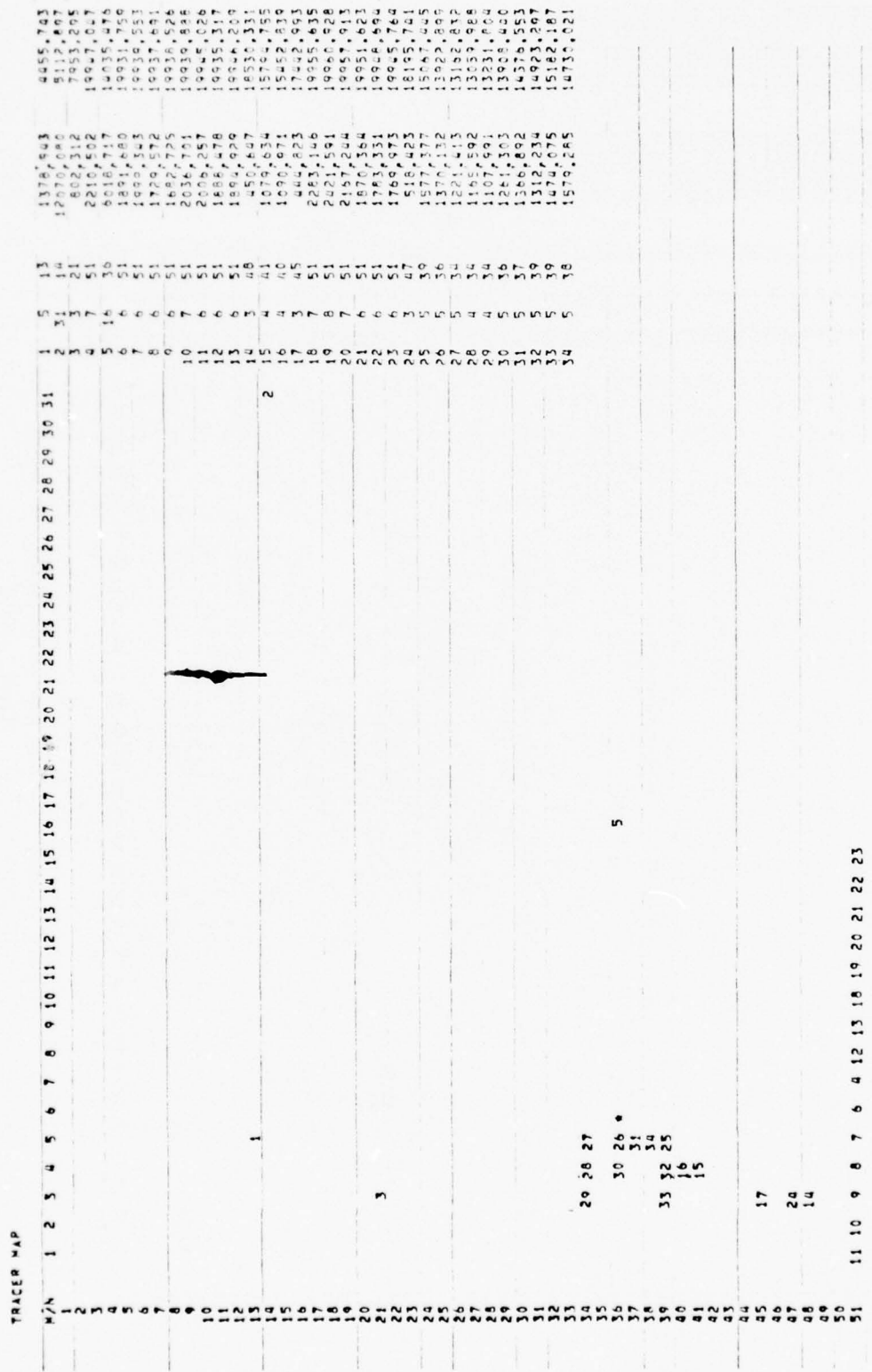


Figure A.5(b) TRACER MAP AT TIME=55.56 HOURS  
(n=6, m=36)

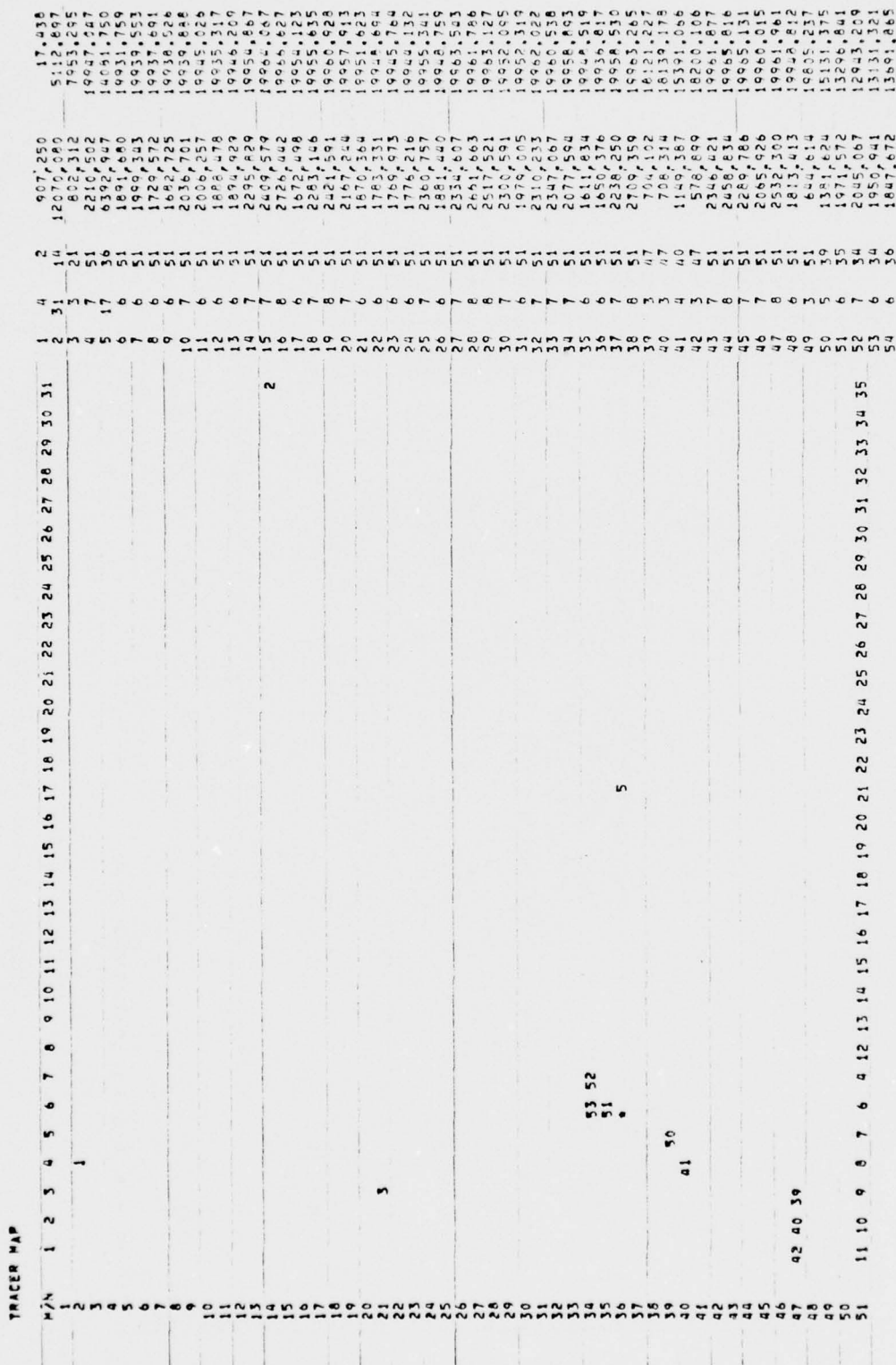
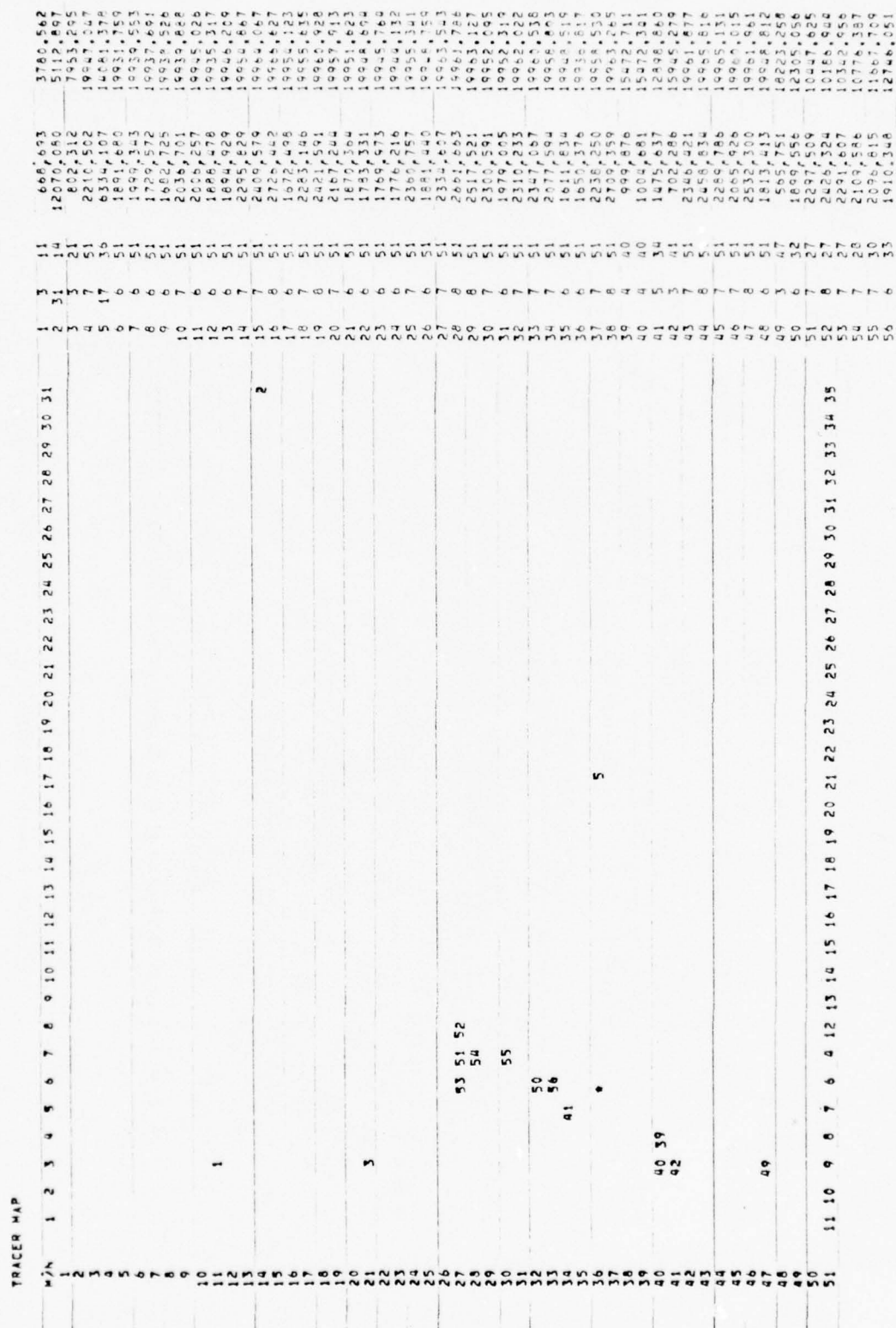
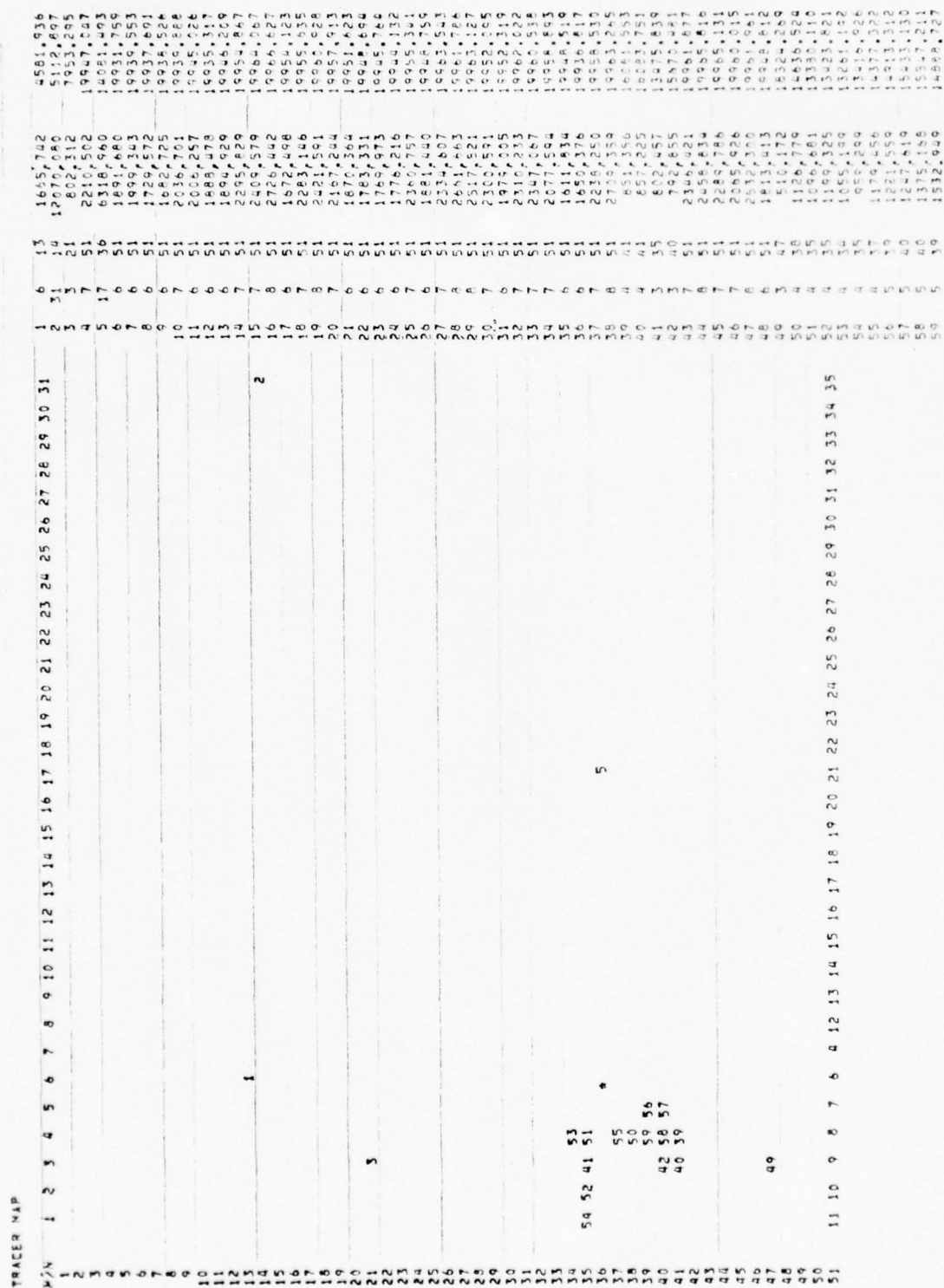


Figure A.5(c) TRACER MAP AT TIME=94.44 HOURS  
(n=6, m=36)





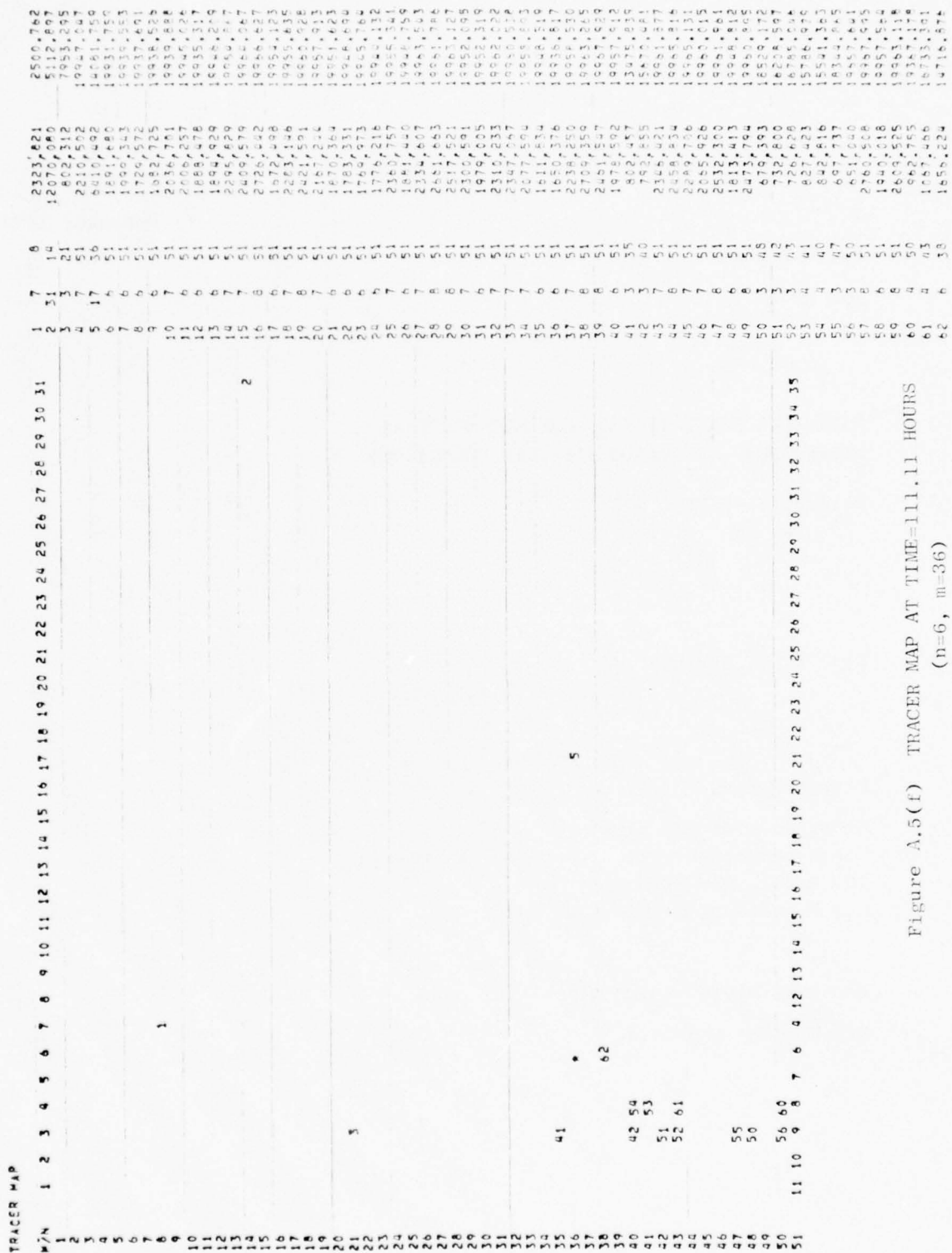


Figure A.5(f) TRACER MAP AT TIME=111.11 HOURS  
(n=6, m=36)

December 1974

Final Report

EGU-2774

NUMERICAL SIMULATION OF DREDGED MATERIAL  
DISPERSION--SAN PABLO BAY (SAN FRANCISCO)

Volume II--USERS' MANUAL

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San Francisco, California 94102

Contract DACW07-73-C-0075

SRI Project EGU-2774

## SUMMARY

One phase of the Dredge Disposal Study is to develop procedures for predicting the dispersion and deposition of dredged sediment in San Francisco Bay. This volume is the formal documentation of a computer simulation model which was developed to trace the movement of deposited particles in the San Pablo Bay area of San Francisco Bay. The computer model is called DREGSIM and is implemented on the CDC 7600 computer system.

Users' instructions and descriptions of all input data are presented. In addition, example input data are provided, and a complete listing of the DREGSIM computer program is presented in the Appendix. Example output of the program are presented in Volume I of this report.

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## I INTRODUCTION

Volume I of this report discussed the general features of the DREGSIM computer model and outlined the scope and limitations of the numerical model. In this volume, example inputs are given to acquaint the user with the procedures for using the computer code. Although this report necessarily contains some computer terms, it is intended primarily for non-programmers. Users with minimal knowledge of the DREGSIM model should be able to prepare the required input data and exercise the model.

This report is part of a larger dredging study of San Francisco Bay undertaken by the San Francisco District of the U.S. Army Corps of Engineers. Interested users should contact that office for information relating to this study as well as the larger study.

The intent of this users' manual is to allow the staff of the San Francisco District of the U.S. Army Corps of Engineers to use and experiment with the DREGSIM numerical simulation model. This manual applies only to the San Pablo Bay site and to the CDC 7600 computer at the Lawrence Laboratory in Berkeley, California. The code can be transferred to other computing systems with a FORTRAN IV compiler; however, there are several site-dependent functions that would have to be changed and which will not be enumerated here.

## II THE DREGSIM PROGRAM

### 2.1 Introduction

The DREGSIM computer program consists of four types of routines, (a) initialization routines, (b) simulation routines, (c) input/output routines, and (d) boundary routines. Each of these four types is discussed at length below, with major emphasis on the input/output routines.

### 2.2 Initialization Routines

The initialization routines are as follows:

1. DREGSIM - is a dummy main program
2. MIAB - Sets up boundary types
3. SETUP - controls operation of the program
4. CHEZY - calculates Chezy coefficients
5. TIDINT - Finds slack tide time
6. INIT1 - Initializes variables
7. TIDEIN - Initializes tide generator
8. INIAL - Initializes surface variables

All of these routines are called once at the beginning of each new simulation and are not used thereafter except for SETUP, which is the control center of the program. It would be possible and perhaps desirable to call CHEZY at each time step and calculate the coefficients based on the actual water depth at that time. The program logic for doing this is straightforward.

### 2.3 Simulation Routines

The simulation routines consist of the following subroutines:

1. FIND - Sets up the cell solution sequence
2. HYDRO1 - Establishes central computation scheme
3. ZERO - Clears storage arrays for each time step
4. DIFFUS - Calculates turbulent diffusion
5. SETVAR - Sets variables from arrays
6. EDDY - Calculates turbulent diffusion coefficients
7. TRACE - Is the Lagrangian tracer simulation routine
8. TDIAG - Solves tridiagonal matrix
9. TIDE - Generates a tide level at each time step
10. RESET - Resets initial tide
11. DRYCEL - Finds and flags dry cells
12. DIVERG - Calculates cell divergence
13. REDANG - Redefines angle
14. SHIFT - Shifts U, V, and  $\bar{\epsilon}$
15. UVINT - Interpolates for U and V for tracer simulation
16. SCON - Is the mean concentration simulation routine

Although it is possible to consolidate some of the above routines, this was not done in order to retain the modular format of the model and to be able to experiment with the various components. It is instructive to examine EDDY, HYDRO2, DIFFUS, TRACE and SCON in more detail.

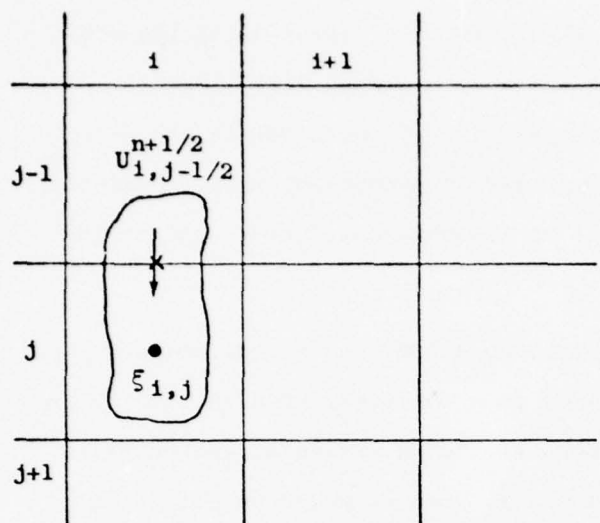
Subroutine EDDY calculates the anticipated energy dissipation in the unresolvable sub-grid-scale range. In this model the SGS dissipation is calculated as a function of the mean flow shear rate and a parameter of scale ( $\Omega$ ). The scaling parameter should have a value between 0.10 and 0.001 with 0.005 being a reasonably good estimate; see Spraggs and Street.<sup>1</sup>

Subroutine DIFFUS calculates the turbulent diffusion using the eddy coefficients calculated in EDDY. It has been shown by Hirt<sup>2</sup> that the inclusion of this term increases the stability of the model if the eddy coefficient is large enough. The model uses a psuedo-implicit scheme and should not need the term, but because of its physical interpretation the diffusion term is retained.

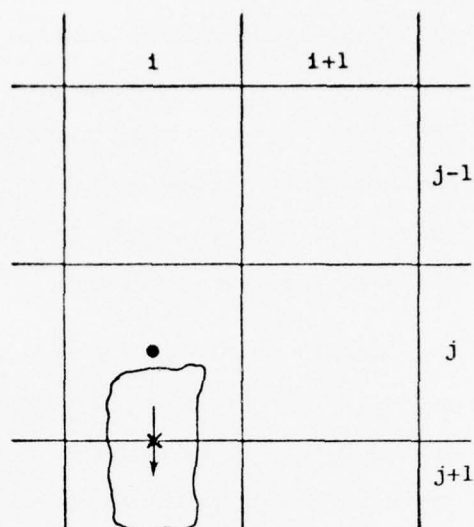
HYDRO2 is an entry point in Subroutine HYDRO1 and is the computational center of the program. The scheme used is a four-step process similar to that outlined by Leendertse.<sup>3</sup> However, if the inclusion of upwind differencing terms produces an explicit model, then it would be better to adopt a two-step explicit scheme which would be considerably faster. One inconsistency in the code that should be noted is the way in which the indices are calculated in Steps 1 and 3. Figure 2.1 shows the location of the variables for each of the four steps. In steps 1 and 3 the calculation of  $U^{n+1}$  and  $V^{n+1}$  is at a different location than in steps 4 and 2, respectively. This scheme is computationally more efficient and has been retained at the risk of hindering future code modifications.

Subroutine TRACE provides a Lagrangian solution of the simulated tagged tracer particles. The primary feature of the routine is finding the appropriate convecting velocities as a function of the depth and surrounding cell velocities. The complete scheme is given in Sec. 4.4 of Volume I. Subroutines UVINT and INTER perform the actual interpolation as outlined.

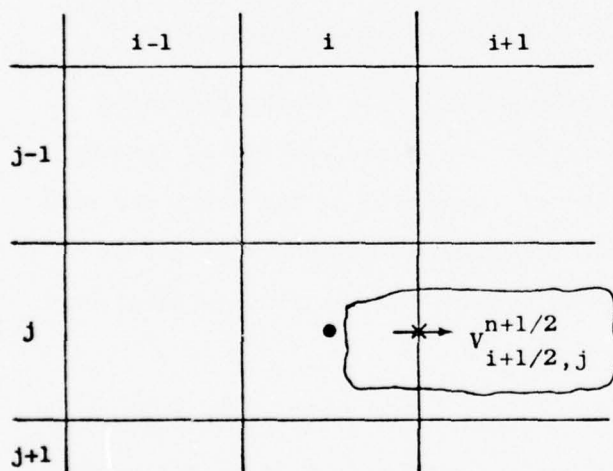
Subroutine SCON is the code for the finite difference model given in Eq. (4.8) of Volume I. Here the velocities required at  $n+1/2$  are assumed to be a simple average of the  $n$ th and  $n+1$ st time steps. Eddy coefficients are assumed to be identical to the eddy coefficients used in the hydrodynamics simulation.



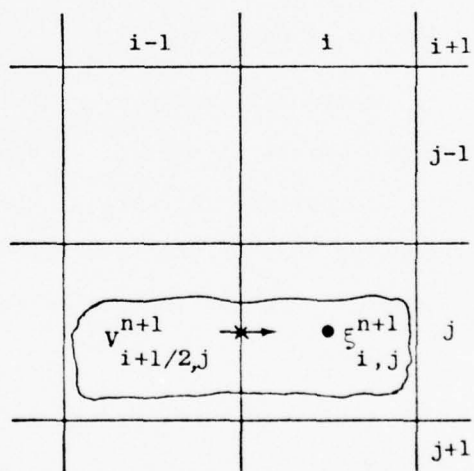
(a) Step 1  $U_{1,j-1/2}^{n+1/2}, \xi_{1,j}^{n+1/2}$



(b) Step 4  $U_{1,j+1/2}^{n+1}, \xi_{1,j}^{n+1/2}$



(c) Step 2  $V_{i+1/2,j}^{n+1}, \xi_{i+1/2,j}^{n+1/2}$



(d) Step 3  $V_{i-1/2,j}^{n+1}, \xi_{i,j}^{n+1}$

FIGURE 2.1 VARIABLE LOCATION FOR CALCULATION OF U AND V

Subroutine TIDE provides a reasonable tide at the ocean boundary for each time step. A simple tide generator is used because sufficient data records in computer compatible format are not available for the many test runs to be made. The routine can be easily modified to read a value for WATLEV at each time step if the user so desired.

#### 2.4 Input/Output Routines

The input/output routines consist of the following subroutines:

1. PUTOUT - Prints U, V,  $\xi$
2. PETR/C - Writes tracer information to magnetic tape
3. DATARD - Reads initial parameters from magnetic tape
4. DEPTH - Reads depth information
5. PRNT - Writes initial information
6. TAPDAT - Reads initial data from magnetic tape
7. PRNTR - Prints tape diagnostics
8. TRCOUT - Prints tracer locations
9. DATAWT - Writes initial parameters on magnetic tape
10. PNORM - Prints normalized concentration map

All of these routines are simple and require no further explanation.

#### 2.5 Boundary Routines

The boundary routines are all used to set variables at boundaries where values are needed in the numerical model. The subroutines are:

1. EXTND - Sets U, V and  $\xi$  values for dry cells
2. BNDRY - Sets boundary values for UBND and VBND
3. SETBNX - Sets computational parameters in X-direction
4. UBND - Resets open boundaries in X-direction
5. VBND - Resets open boundaries in Y-direction

8. UELBND - Calculates U-velocity of inflows at open land boundaries

7. VELBND - Calculates V-velocity of inflows at open land boundaries

The boundary conditions incorporated in the above subroutines are based on experimentation and theoretical considerations as outlined in Section III below.

### III BOUNDARY AND INITIAL CONDITIONS

Boundary and initial conditions for the hydrodynamics model are extremely complex and generally the data are not available for a complete determination. The boundary conditions usually consist of a tidal wave at the ocean entrance, tributary inflow data at open land boundaries and some model for the solid boundaries. Initial conditions should consist of the water surface elevation and transport velocities at each cell. Precise numerical values for these conditions are generally not available, and the model uses the alternative methods of obtaining initial conditions, as described below.

#### 3.1 Boundary Conditions

Specifying appropriate boundary conditions at the extremities of the model or at water/land interfaces is usually very difficult and often leads to serious numerical problems in the model. The most difficult task is prescribing open boundaries, because the influence of upstream activities cannot be included. Hence, the predominant variable at the opening is prescribed as carefully as possible and the remaining variables are chosen in relation to this prescribed variable. At ocean boundaries one can quite safely prescribe the tide and calculate the incoming velocities from continuity and by assuming that the flow is parallel as it enters the Bay. For example, at Point San Pablo where the tide is prescribed, one can assume that  $V=0.0$  for each time step and  $\xi^n$  and  $\partial \xi / \partial t$  are known, then

$$\frac{\partial}{\partial x} [U(h + \xi)] = - \frac{\partial \xi}{\partial t}$$

Consequently, it is possible to determine the corresponding velocity which accompanies the prescribed tide change.

Open landward boundaries (such as tributaries) are not as easy to prescribe because they are influenced both by the incoming tide and the volume of fresh water inflow from upstream. Therefore, it is not enough simply to set these velocities because that causes too great an impedance to the incoming tide. In DREGSIM, the velocity at the boundary considers both the flow of fresh water from upstream and the height of the incoming tide. Assuming that the river flow is specified as  $Q_R$ , then the average velocity through a cross-section of the river at the opening is  $Q_R/A_c$ , where  $A_c$  is the cross-sectional area calculated using the simple trapezoid rule. Next, the velocity at the boundary is found to be

$$U_b = \frac{Q_R}{A_c} \left\{ 1.0 - e^{-K(TIDEMX - DLAYTID)} \right\},$$

where  $K$  is a constant,  $TIDEMX$  is the maximum tide and  $DLAYTID$  is the delayed tide. This boundary condition has been found to be a good representation of the tidal influence at the fresh water source.

Boundary conditions at the land/water interface are assumed to be:

1. No slip for tangential velocities
2.  $\frac{\partial^2 U}{\partial N^2} = 0.0$  for normal velocities
3.  $\frac{\partial \xi}{\partial N} = 0.0$  for surface calculations
4.  $\frac{\partial S}{\partial N} = 0.0$  for concentration calculations.

These boundary conditions have been found to work reasonably well in the test cases that have been run. At fresh water open boundaries where the flow is large it would be advisable to extend the grid upstream to obtain a better simulation and reduce the influence of the boundary.

### 3.2 Initial Conditions

The prescription of a complete set of initial conditions for any bay is probably not possible. Consequently, it is necessary to begin the model with all initial conditions at zero and then generate initial conditions by running the model for two or more tidal cycles and storing the final results on magnetic tapes. These results can then be used as the initial conditions for subsequent simulations.

Poor guesses for initial conditions are not important because the strong forcing functions at the openings tend to force the solution to a reasonable conclusion. It should be pointed out that the generated initial conditions do not represent a realization of the real system. Rather, they are within the range of realizations that could occur, and they correspond qualitatively to the general circulation pattern that would develop in the bay for a similar forcing function.

The initial condition for the dredged material can likewise be set to zero, because this study considers only the perturbation in the system caused by the dredged material. If the objective is to determine all the sediment transport, then a knowledge of the existing conditions and a time history of sediment inflows would be needed. However, since this is not the case, the zero initial condition is appropriate.

### 3.3 Tracer Initialization

Two methods are available for prescribing the initial position of tracers. First, tracers can be input at any cell in the system. These tracers are controlled by the input parameter NTRAC. Second, tracers are automatically input at the disposal site every hour. The dumping site NMDUMP is defined by the following rule:

$$NMDUMP = N * 100 + M$$

For example, for a dredged material disposal site at N=6 and M=36,  
NMDUMP=636. Tracers input using the NTRAC option are read in as follows:

```

      DO 510 K=1, NTRAC
      READ (5,5003) N, M, DIAM(K), ZLOC
510    CONTINUE
5003   FORMAT (2(10X, I5), 2(10X, F10.0)),

```

where DIAM(K) is the equivalent particle diameter in microns and ZLOC  
is the depth of entry of the particle in feet or meters. A typical  
input card is as follows:

<u>Card Columns</u>	<u>Data</u>
15	6
24-30	36
47-50	20.0
68-70	2.0

Other input data are described in detail in Section IV. Calculations<sup>4</sup>  
for the tracer source terms are shown in Table 3.1. The computational grid  
for San Pablo Bay is as shown in Figure 3.1.

Table 3.1  
SOURCE TERM CALCULATIONS

A. Rate of Dredging

- |                              |                            |
|------------------------------|----------------------------|
| 1. Number of loads per day   | 22 loads/day               |
| 2. Dredged material per load | 2700 yd <sup>3</sup> /load |
| 3. Solids per cubic feet     | 28 lb/ft <sup>3</sup>      |

If the dumping is assumed to be continuous:

$$\begin{aligned}\text{Dumping rate} &= 22 \frac{\text{loads}}{\text{day}} \times 2700 \frac{\text{yd}^3}{\text{load}} \times 28 \frac{\text{lb}}{\text{ft}^3} \times 27 \frac{\text{ft}^3}{\text{yd}^3} \times \frac{1}{86400} \frac{\text{day}}{\text{sec}} \times 454 \frac{\text{g}}{\text{lb}} \\ &= 23.6 \times 10^3 \text{ grams/second}\end{aligned}$$

B. Weight of Iridium Tracer Particle

- |                                  |                        |
|----------------------------------|------------------------|
| 1. Particle Diameter             | $20 \times 10^{-4}$ cm |
| 2. Specific density <sup>5</sup> | 2.6 g/cm <sup>3</sup>  |

$$\begin{aligned}\text{Weight per particle} &= 2.6 \frac{\text{g}}{\text{cm}^3} \times \frac{\pi}{6} (20 \times 10^{-4} \text{ cm})^3 \\ &= 1.09 \times 10^{-8} \text{ grams}\end{aligned}$$

C. Number of Iridium Tracer Particles in 20,000 Pounds

$$\begin{aligned}\text{No. of Particles} &= 2 \times 10^4 \text{ lb} \times 454 \frac{\text{g}}{\text{lb}} / (1.09 \times 10^{-8} \frac{\text{g}}{\text{particle}}) \\ &= 8.33 \times 10^{14} \text{ particles}\end{aligned}$$

D. Rate of Deposit of Iridium Tracer Particles

- |                               |         |
|-------------------------------|---------|
| 1. Number of days of dredging | 38 days |
|-------------------------------|---------|

$$\begin{aligned}\text{Rate of deposit} &= 8.33 \times 10^{14} \text{ particles} \times \frac{1}{86400} \frac{\text{day}}{\text{sec}} / (38 \text{ days}) \\ &= 2.54 \times 10^8 \text{ particles/second}\end{aligned}$$

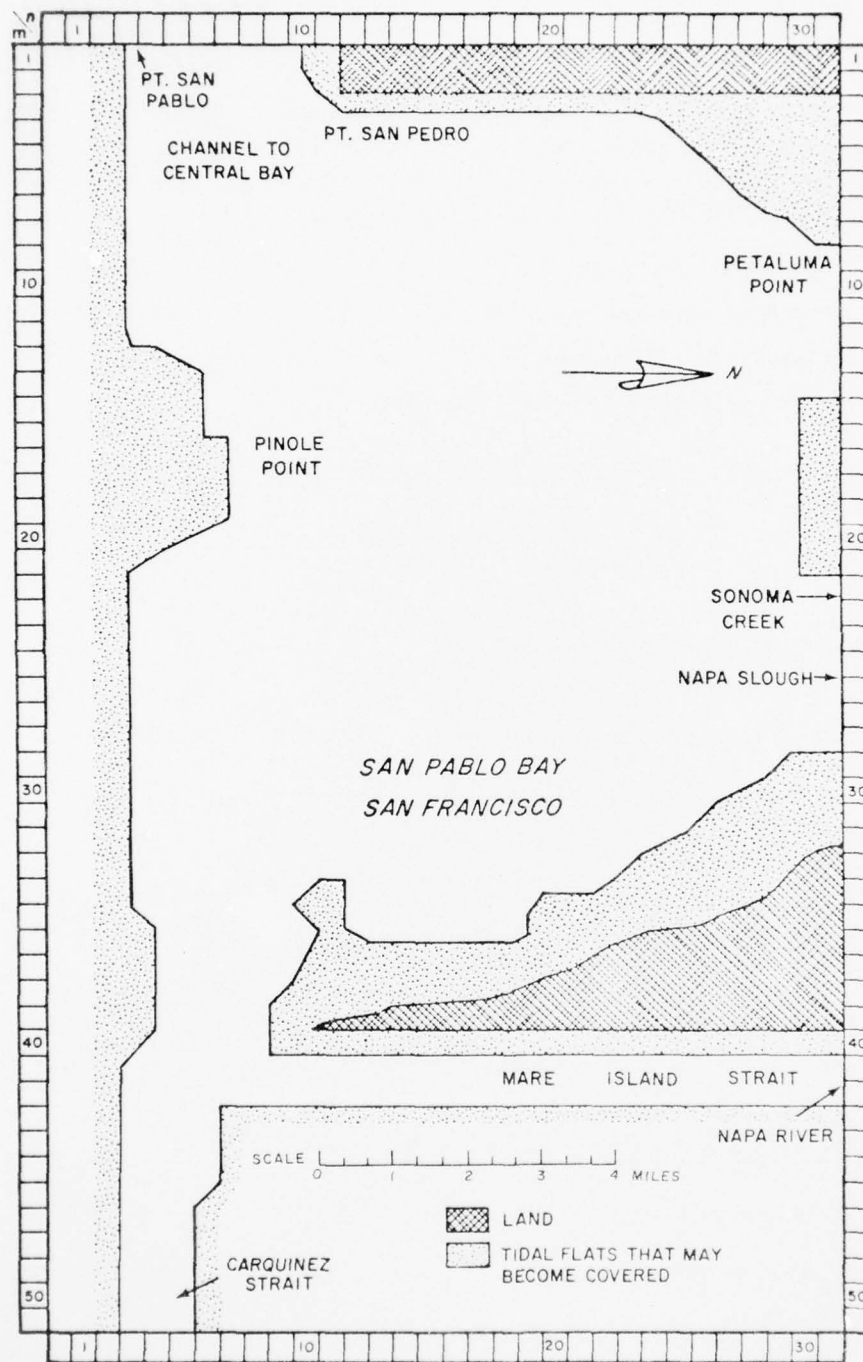


FIGURE 3.1 COMPUTATIONAL GRID - SAN PABLO BAY

## IV DREGSIM INPUT

4.1 Logicals

Currently there are seven logical controls as well as controls on time, output, and input. The logicals are used to determine the type of simulation being run. The logicals and the corresponding program interpretation are as follows:

<u>Logical</u>	<u>Program Interpretation if .TRUE.</u>
TAPEIN	<u>input</u> from magnetic <u>tape</u>
TAPEOU	<u>output</u> to magnetic <u>tape</u>
PRTCLS	simulate <u>particle</u> movement
RESTRT	<u>restart</u> from magnetic tape
PROT	diagnostic print-out of <u>tape</u>
METER	<u>metric</u> input
NEWPRT	begin <u>new</u> particle simulation

These logicals are specified in the first card of the input deck using a format of 7L2. For example,

```

      F T T F F F F

```

would assign a value of .TRUE. to TAPEOU and PRTCLS, and would assign a value of .FALSE. to the remaining logicals. The logicals RESTRT, PROT and NEWPRT will always be .FALSE. unless TAPEIN=.TRUE. The specification of PROT=.TRUE. should be used with caution as it may result in a large volume of printed output.

## 4.2 Site Descriptors

Program variables designated as site descriptors are used to transform the physical site into numerical terms for simulation. Table 4.1 lists the program variables and the site descriptor they represent. Figure 4.1 shows an example set of data that can be used as input to the DREGSIM program. The following FORTRAN statements are actually used to read in the values for the variables for (a) a new start and (b) for a restart using data stored on tape by a previous run of the program.

### Case A (New Start)

```
READ (5,5000) MMAX, NMAX, MINDO, NINDO, NTRAC
READ (5,5006) (TITL (J), J=1, 12)
READ (5,5007) LATUDE, LONGIT, YEAR, DAY, HOUR
READ (5,5007) DELX, DELY, DELT, WINDX, WINDY
READ (5,5007) HHW, DATUM, SOURCE
READ (5,5002) MAXST, NI, INLET, IJDUMP, NOUT
READ (5,5001) (MOBD (M), QBNDU (M), TIMDLX (M), M=1,MINDO)
READ (5,5001) (NOBD (N), QBNDV (N), TIMDLY (N), N=1,NINDO)
DO C M=2, MMAX
C  READ (5,0001) ROW, CARD, (H(N,M), N=2, NMAX)
    IF (PRTCLS) D,F
D  DO E K=1, NTRAC
E  READ (5,5003) N,M, DIAM (K), ZLOC
F  CONTINUE
```

Table 4.1  
PROGRAM VARIABLES

Program Variable	Site Descriptor or Definition
MMAX, NMAX	number of cells in X- and Y-direction
MINDO, NINDO	number of openings in X- and Y-direction
NTRAC	number of initial tracers
TITL	alphanumeric title of study area
LATUDE, LONGIT	latitude and longitude of starting point (X=0.0, Y=0.0)
YEAR, DAY, HOUR	year, day, and hour of study
DELX, DELY	cell spacing in X- and Y-direction (feet)
DELT	desired time increment (seconds)
WINDX, WINDY	wind speed in X- and Y-direction (feet/second)
HHW	mean higher high-water (feet)
DATUM	mean reference depth level (feet)
SOURCE	dredged material input (Kilogram/second)
MAXST	maximum number of time steps
NI	number of ocean openings
INLET	orientation and position of ocean opening
IJDUMP	location of dumping site
NOUT	output every NOUT steps
MOBD, NOBD	open boundaries in X- and Y-directions
QBNDU, QBNDV	inflow volume at MOBD, NOBD (feet <sup>3</sup> /second)
TIMDLX, TIMDLY	time for tide to go from inlet to MOBD, NOBD (minutes)
H	depth from mean reference level at each grid intersection (feet)
ROW	row or M number for current set of depth data
CARD	card number for current row of depth data
N, M	cell location of tracer particle dump
DIAM	equivalent tracer particle diameter in microns
ZLOC	initial depth of entry for tracer particles (feet)

```

F T T F F F F
MMAX= 51 NMAX= 31 MINDO= 2 NINDO= 3 NTRAC= 6
SAN PABLO BAY S. F.
LAT 38. LONGT 108. YEAR 1958. DAY 45. HOUR 0.
1320. 1320. 60. 0. 0.
7.00 .001 236.0
MAXST 300 NI= 1 INLET 13 IJDP 636 NOUT 25
00104090
15103051 10000.0 37.0
13109141 1000.0 10.0
13122281 1000.0 15.0
13141421 1000.0 20.0
1 1 -20.0 9 64 72 74 72 50 9-20.0-99.9
2 1 -20.0 9 24 52 70 74 72 15 15 8 3 3 2 2 0
2 2 0 0 0 0 0 -9 -9 -9 -9 -9 -9 -9 -20.0-99.9
3 1 -20.0 9 10 26 48 72 66 30 16 13 11 9 6 4 3
3 2 2 2 1 1 0 0 0 -1 -1 -2 -9 -9 -9-99.9
4 1 -20.0 9 9 16 46 49 50 48 40 16 88 8 8 7 6
4 2 5 3 2 2 1 0 0 0 -1 -2 -4 -9 -9-99.9
5 1 -20.0 9 9 10 35 43 46 45 36 29 16 7 8 6 5
5 2 5 4 3 3 2 3 3 1 1 0 -2 -4 -9 -9-99.9
6 1 -20.0 9 9 10 28 41 44 43 39 30 20 10 8 7 6
6 2 5 5 4 3 3 3 3 2 1 0 -1 -2 -9-99.9
7 1 -20.0 9 9 9 14 37 41 40 40 30 23 18 12 9 8
7 2 9 8 6 5 5 4 3 3 3 2 1 0 0 -9-99.9
8 1 0 9 9 9 9 32 38 39 38 33 19 15 14 10 7
8 2 5 7 7 8 4 4 4 2 2 2 2 1 0 -9-99.9
9 1 0 9 9 9 9 24 35 38 38 37 19 16 12 9 9
9 2 12 6 5 7 5 5 4 4 3 2 2 2 2 2-99.9
10 1 0 9 9 9 9 18 32 39 38 37 24 15 14 9 7
10 2 9 7 6 5 5 5 4 4 4 3 2 2 2 2-99.9
11 1 0 9 9 9 9 14 30 36 38 37 25 15 13 10 8
11 2 7 7 9 5 5 4 4 4 4 3 2 2 2 2-99.9
12 1 -9 0 9 9 9 10 25 33 40 35 34 14 12 11 8
12 2 7 6 6 9 6 4 4 4 4 3 3 3 2 2-99.9
13 1 -9 -9 0 9 9 10 20 33 40 33 30 15 11 11 9
13 2 8 6 5 5 5 6 6 5 5 5 5 5 5 3-99.9
14 1 -9 -9 0 9 9 9 18 33 41 33 33 16 10 10 10
14 2 8 6 5 5 5 5 5 4 3 2 2 2 2 -9-99.9
15 1 -9 -9 -9 0 3 7 21 32 38 33 32 20 10 9 9
15 2 8 7 6 5 5 5 4 4 3 2 2 2 1 -9-99.9
16 1 -9 -9 -9 0 3 10 20 28 34 34 31 21 9 8 9
16 2 8 7 6 6 5 5 4 4 3 3 2 1 1 -9-99.9
17 1 -9 -9 -9 0 3 9 20 25 33 34 29 20 9 8 8
17 2 8 7 6 6 5 5 4 4 3 3 3 2 1 -9-99.9
18 1 -9 -9 0 0 4 10 19 26 32 33 28 22 9 7 7
18 2 8 7 6 5 5 5 4 4 3 2 3 2 1 -9-99.9
19 1 -9 0 1 2 5 11 16 25 30 33 26 16 10 7 6
19 2 7 7 6 5 5 5 5 4 3 3 2 2 1 -9-99.9
20 1 0 1 1 2 7 11 17 26 32 31 25 20 10 7 6
20 2 7 7 6 5 4 4 4 4 3 2 2 2 1 -9-99.9
21 1 0 1 2 5 8 12 20 26 27 29 23 15 9 7 6
21 2 7 6 5 5 5 4 4 3 3 2 2 1 1 1-99.9

```

FIGURE 4.1 INPUT DATA--SAN PABLO BAY

22 1	0	2	3	6	10	14	18	23	25	26	21	15	8	7	6
22 2	5	6	6	5	5	4	4	3	3	2	1	1	1	1	1-99.9
23 1	0	2	5	6	9	14	21	25	27	27	19	12	7	7	6
23 2	6	6	6	5	5	4	4	3	3	2	1	1	1	1	1-99.9
24 1	0	3	5	6	10	17	20	25	26	26	15	11	7	7	6
24 2	6	5	5	5	5	4	4	3	2	2	2	1	1	1	1-99.9
25 1	0	4	5	7	10	17	21	23	24	21	16	10	7	7	6
25 2	5	5	5	4	4	4	3	3	2	2	2	1	1	1	1-99.9
26 1	0	5	5	8	12	18	24	26	27	22	14	7	6	6	7
26 2	5	5	4	4	4	4	3	3	3	2	1	1	1	1	1-99.9
27 1	0	5	5	8	14	20	25	27	28	17	12	6	5	5	4
27 2	5	5	4	4	4	3	3	3	2	2	2	1	1	1	1-99.9
28 1	0	4	7	9	14	22	26	24	22	15	7	5	5	5	5
28 2	4	4	4	4	4	3	3	2	1	1	1	1	0	0	-9-99.9
29 1	0	4	5	9	15	23	27	25	20-20.0	5	5	5	5	5	5
29 2	4	4	4	3	3	2	2	1	1	1	1	0	-1	-1	-9-99.9
30 1	0	5	6	11	16	27	31	25	16-20.0	5	5	5	5	4	4
30 2	4	4	3	3	2	2	1	1	0	0	-1	-2	-4	-4	-9-99.9
31 1	0	5	7	11	20	29	32	25	9-20.0	4	4	4	4	3	3
31 2	3	3	2	2	2	1	1	1	0	-1	-2	-4	-9	-9	-9-99.9
32 1	0	2	7	11	24	29	35	21	9-20.0	3	3	3	3	3	2
32 2	2	2	2	1	1	0	0	-1	-2	-3	-4	-6	-9	-9	-9-99.9
33 1	0	1	7	15	24	34	38	12	8-20.0	2	3	2	2	2	2
33 2	2	2	1	1	1	0	-1	-2	-4	-9	-9	-9	-9-99.9	-9	-9-99.9
34 1	-9	0	10	14	35	45	32	10	7-20.0	1	2	1	1	1	1
34 2	1	0	-1	-2	-3	-4	-6	-8	-9-99.9						
35 1	-9	0	15	20	35	45	28	10	-1-20.0	0	0	0	0	0	0
35 2	0	-3	-3	-4	-6	-9	-9	-9	-9-99.9						
36 1	-9	0	17	21	55	42	25	0	-3	-3	-3	-3	-4	-6	-8
36 2	-9	-9	-9	-9	-9-99.9										
37 1	-9	0	20	25	50	40	0	-4	-4	-4	-5	-5	-5	-6	-8
37 2	-9-99.9														
38 1	-9	0	30	45	45	26	0	-2	-4	-6	-9	-30.	-30.	-30.	-30.
38 2	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-99.9
39 1	0	17	35	40	50	18	0	0	0	0	0	0	0	0	0
39 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0-99.9
40 1	0	17	52	50	50	14	9	9	9	9	9	14	21	25	
40 2	19	18	14	16	20	23	26	28	22	18	15	15	18	18-99.9	
41 1	0	17	56	55	0	0	0	0	0	0	0	0	0	0	0
41 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0-99.9
42 1	0	17	60	55	0	-9	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.
42 2	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-30.	-99.9
43 1	0	17	60	55	0	-9-99.9									
44 1	0	17	60	55	0	-9-99.9									
45 1	0	17	60	0	-9-99.9										
46 1	0	17	60	0	-9-99.9										
47 1	0	17	60	0	-9-99.9										
48 1	0	17	60	0	-9-99.9										
49 1	0	17	60	0	-9-99.9										
50 1	0	17	60	0	-9-99.9										

FIGURE 4.1 (Continued)

#### Case B (Restart)

```
READ (5,5002) MAXST, NOUT
READ (5,5007) DELT, WINDX, WINDY
READ (5,5007) SOURCE
READ (5,5002) IJDUMP
READ (5,5001) (MOBD (M), QBNDU (M), TIMDLX (M), M=1, MINDO)
READ (5,5001) (NOBD (N), QBNDV (N), TIMDLY (N), N=1, NINDO)
IF (NEWPRT) D,F
D READ (5,5002) NTRAC
DO E K=1, NTRAC
E READ (5,5003) N,M, DIAM (K), ZLOC
F CONTINUE
```

A -99.9 entry in a depth data card is used to indicate the end of data for that particular row. The card formats are as follows:

```
5000 FORMAT (5,(7X, I3))
5001 FORMAT (2X, I8, 2F10.0)
5002 FORMAT (5(5X, I5))
5003 FORMAT (2(10X, I5) 2(10X, F10.0))
5004 FORMAT (7L2)
5005 FORMAT (2I2, 1X, 15F5.0/(5X, 15F5.0))
5006 FORMAT (12A6)
5007 FORMAT (5(5X, F5.0))
```

#### 4.3 Explanations

Several previously mentioned variables require more explanation and are discussed in this section.

INLET is an integer variable used to specify the opening which opens to the ocean. The value of the variable is determined as follows:

$$\text{INLET} = N * 10 + S \text{ (or } M * 10 + S \text{)}$$

where N (or M) is the column (or row) that contains the opening and S is a numeric code to indicate the side of the column (or row) where the opening occurs. If the opening is along the X-direction, then the value of S is either 1 or 3 depending whether the opening is on the top or bottom side of the row of cells containing the opening. If the opening is along the Y-direction, then the value of S is either 2 or 4 depending whether the opening is on the right or left side of the column of cells containing the opening. Referring to Figure 4.1, the ocean opening near Point San Pablo is  $\text{INLET}=13$ , since  $M=1$  and the opening is on the bottom side of the cells between  $N=4$  and  $N=9$ . However, if the ocean opening is near Petaluma Point, then  $\text{INLET}=314$ ; since  $N=31$  and  $S=4$ . If the ocean opening is at the Carquinez Strait, then  $\text{INLET}=511$ , since  $M=51$  and  $S=1$ .

IJDUMP is the dump site identifier and is defined as  $\text{IJDUMP}=N*100+M$ . For example, if the dump site is at cell  $N=6$ ,  $M=36$ , then  $\text{IJDUMP}=636$ .

MOBD and NOBD are eight-digit codes defining the open boundaries along the X- and Y-directions, respectively. The codes for MOBD (or NOBD) are as follows:

<u>Digit</u>	<u>Data</u>
1	Type of open boundary. 0 means open ocean boundary. 1 means open landward boundary.
2 and 3	The row (or column) where the open boundary is located.
4 and 5	The first column (or row) of the open boundary.
6 and 7	The last column (or row) of the open boundary.
8	A code to indicate the side where the opening occurs. A 0 means the opening is on the bottom (or right) side of the column (or row) of open cells. A 1 means the opening is on the top (or left) side.

For example, referring to Figure 4.1:

(a) The opening for Carquinez Strait is

```
MOBD = 15103051
      - open upper boundary
      -- N last is 5
      -- N first is 3
      -- M=51
      - open landward boundary
```

(b) The opening near Point San Pablo is

```
MOBD = 00104090
      - open lower side
      -- N last is 9
      -- N first is 4
      -- M=1
      - open ocean boundary
```

(c) The opening for Mare Island Strait is

```
NOBD = 13141421
      - open left side
      -- M last is 42
      -- M first is 41
      -- N=31
      - open landward boundary
```

Each open boundary must be described in this way so that appropriate boundary conditions can be set. The remainder of the data is obvious from Figure 4.1.

#### 4.4 CDC 7600 Control Cards

The sequence of control cards shown in Figure 4.2 is the minimal set for running the DREGSIM program using stored data. Note that the data is stored as an UPDATE file to facilitate changing the data.

```

DREDGE,12,64,150000.803828,SPRAGGS,L
*PSS
FETCHPS,DREDGE,DREGSIM,DREGSIM.
UPDATE,F,P=DREGSIM.
REWIND,OUTPUT.
RETURN,DREGSIM.
RUN76,I=COMPILE,NL77777.
RETURN,COMPILE.
FETCHPS,DREDGE,PABLO,PABLO.
RETURN,COMPILE.
UPDATE,F,P=PABLO,C=TAPE7,D.
RETURN,PABLO.
LGO.
7/8/9
7/8/9
*IDENT PABLOFX
*D PABLO.2
7/8/9
  F T T F F F F
INFILE= 7
7/8/9
6/8/9

```

FIGURE 4.2 CDC 7-60 CONTROL CARDS.

#### 4.5 Online Program

Part of the objective of this study was to explore the possibility of using the DREGSIM program in an on-line mode. Figure 4.3 shows a typical run using the on-line version. However, considerable work is necessary before the DREGSIM can become a viable model using the Berkeley system. A major disadvantage with the present system is the voluminous output generated. It would be possible to reduce the output if the remote system was equipped with a plotting system so that the particle traces could be observed dynamically.

The limited testing with the on-line version of DREGSIM did indicate that it could be a powerful analysis tool once confidence had been gained with the simulation program. The DREGSIM program should be used in a remote batch mode to obtain information about potential applications. Then, if sufficient justification is generated, the model could be switched to the on-line mode at a suitable installation.

```

>LOG,TEST,12,500,60000,803828,SPRAGGS!
LOGIN CP-10 TIV-090 07.59.46**8KY57A*B*07/19/74.
TEST008 LOGGED IN. SESAME 1.3 ENTERING *EDIT
OK - *EDIT
*LOAD(CONTROL,DREDGE)!
LOAD IN PROGRESS
LOAD COMPLETE, ENTERING *EDIT
OK - *EDIT
*RUN!
BEGIN EDIT
PROT01E!
SL0T EMPTY
RUN76IC!
RUN76
SFLIC!
SFL(50000)
S115A!
SFL(150000)
IC!
SL0T EMPTY
RUN76IR!
NOW TYPE *EOF (RUN76)
*EOF!
BEGIN RUN76 COMPILATION
BEGIN LOAD AND EXECUTION
ENTER ITERATION PRINT OPTION (15)
2!
      NMAX   MMAX   NCARD   MIND0   NIND0   NSECT   NSTAT   NTRAC   LEN   LEN2
      31     51     320     3       4       76     1       7     1581  3794

```

SIMULATION AT TIME = 360.00000

NO	CELL-X	CELL-Y	WZER(K)	X-DIST	TRACER Y-DIST	DEPTH
1	4	2	-0	1.8167E+03	7.7805E+02	1.6154E+01
2	12	9	-0	5.9799E+03	4.4196E+03	5.2579E+00
3	5	21	-0	2.3400E+03	1.0140E+04	1.2193E+00
4	4	50	-0	1.3065E+03	2.5221E+04	1.1735E+01
5	12	30	-0	5.9800E+03	1.5340E+04	1.5241E+00
6	7	36	-0	2.8600E+03	1.8460E+04	1.3487E+01

SEMAX	SEMIN	VMAX	UMIN	VMAX	VMIN
.307	0.	.399	-.250	.250	-.250

BREAKPOINT 1  
 CUS LEFT = 417  
 R!  
 RESTARTING  
 SIMULATION AT TIME = 720.00000

FIGURE 4.3 ONLINE VERSION OF DREGSIM.

AD-A043 790

CORPS OF ENGINEERS SAN FRANCISCO CALIF SAN FRANCISCO--ETC F/G 13/2  
DREDGE DISPOSAL STUDY, SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)  
AUG 77 J F SUSTAR, R M ECKER, W T HARVEY

UNCLASSIFIED

7 OF 7

AD  
A043 790



NL



END  
DATE  
FILMED

9-77

DDC

N0	CELL-X	CELL-Y	WZER(K)	X-DIST	TRACER Y-DIST	DEPTH
1	4	2	-.0	1.7943E+03	7.7113E+02	1.6154E+01
2	12	9	-.0	5.9 26 +03	4.4084E+03	5.2579E+00
3	5	21	-.0	2.3400E+03	1.0140E+04	1.2193E+00
4	4	50	-.0	1.3641E+03	2.5223E+04	1.1735E+01
5	12	30	-.0	5.9800E+03	1.5340E+04	1.5241E+00
6	7	36	-.0	2.8606E+03	1.8460E+04	1.3487E+01

SEMAX	SEMIN	VMAX	UMIN	VMAX	VMIN
.373	0.	.443	-.431	.371	-.250

BREAKPOINT 1  
 CUS LEFT = 405  
 T HYDRO,1PRICL!  
 115605  
 A 115605,1!  
 OK  
 R!  
 RESTARTING  
 ENTER TRACER N0. (12)  
 1!  
 ENTER NEW X , Y , Z  
 1000.!  
 100.!  
 10.!  
 ENTER TRACER N0. (12)  
 0!  
 SIMULATION AT TIME = 900.00000

N0	CELL-X	CELL-Y	WZER(K)	X-DIST	TRACER Y-DIST	DEPTH
1	3	1	-.0	8.9772E+02	9.8096E+01	4.7245E+00
2	12	9	-.0	5.9601E+03	4.3948E+03	5.2579E+00
3	5	21	-.0	2.3399E+03	1.0141E+04	1.2193E+00
4	4	50	-.0	1.4064E+03	2.5224E+04	1.1735E+01
5	12	30	-.0	5.9800E+03	1.5340E+04	1.5241E+00
6	7	36	-.0	2.8625E+03	1.8459E+04	1.3487E+01

FIGURE 4.3 (Continued)

AVERAGE SE AND SEP FOR 2ND HALF OF STRIP 5

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2	0	30	29	28	28	28	28	28	0	0	0	0	0	0	0	0
3	0	36	32	29	28	27	27	26	20	0	0	0	0	0	0	0
4	0	11	20	24	25	25	24	24	22	19	19	20	19	13	6	2
5	0	0	20	23	24	24	23	22	20	18	18	19	17	13	8	4
6	0	0	19	21	22	21	21	20	18	17	17	18	16	13	8	4
7	0	0	23	21	21	20	19	18	17	17	17	18	16	12	8	4
8	0	0	26	23	21	19	19	18	17	16	17	17	15	12	7	4
9	0	0	26	24	21	19	18	17	17	16	16	16	14	11	7	4
10	0	0	24	22	20	18	17	17	16	16	15	15	13	10	6	3
11	0	0	19	19	17	16	16	15	15	14	14	13	11	8	5	2
12	0	0	15	14	14	14	14	13	13	12	12	11	9	6	4	2
13	0	0	11	11	11	11	12	11	11	10	10	9	7	5	3	1
14	0	0	0	8	8	9	9	9	9	8	8	7	5	3	2	1
15	0	0	0	0	6	6	7	7	7	6	6	5	4	2	1	0
16	0	0	0	0	4	4	5	5	5	5	4	4	3	1	1	0
17	0	0	0	0	0	3	3	3	3	3	3	3	2	1	0	0
18	0	0	0	0	0	2	2	2	2	2	2	2	1	0	0	0
19	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0
20	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
36	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
37	0	0	2	2	2	2	2	1	0	0	0	0	0	0	0	0
38	0	0	4	4	3	3	3	2	0	0	0	0	0	0	0	0
39	0	0	6	6	5	5	4	0	0	0	0	0	0	0	0	0
40	0	0	8	8	7	6	5	0	0	0	0	0	0	0	0	0
41	0	10	10	9	8	7	6	2	1	0	0	0	0	0	0	0
42	0	12	12	12	11	9	5	2	1	0	0	0	0	0	0	0
43	0	16	16	16	16	0	0	0	0	0	0	0	0	0	0	0
44	0	19	19	19	19	0	0	0	0	0	0	0	0	0	0	0
45	0	22	22	22	21	0	0	0	0	0	0	0	0	0	0	0
46	0	24	24	23	22	0	0	0	0	0	0	0	0	0	0	0
47	0	27	28	28	0	0	0	0	0	0	0	0	0	0	0	0
48	0	30	31	31	0	0	0	0	0	0	0	0	0	0	0	0
49	0	34	35	35	0	0	0	0	0	0	0	0	0	0	0	0
50	0	33	39	39	0	0	0	0	0	0	0	0	0	0	0	0
51	0	43	44	44	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 4.3 (Continued)

V AND VP

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2	-0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0
3	-0	0	3	4	5	5	7	27	0	0	0	0	0	0	0	0
4	0	-9	-0	5	7	8	11	13	25	28	35	37	33	27	13	5
5	0	0	2	7	7	9	12	14	21	24	32	35	33	25	15	7
6	0	0	5	7	6	9	12	14	15	18	26	36	29	23	14	7
7	0	0	4	5	6	8	10	12	13	14	20	33	27	21	13	7
8	0	-0	-0	0	5	6	9	11	11	13	18	24	24	20	13	6
9	0	-0	-3	-3	1	4	7	9	9	11	16	19	19	17	12	6
10	0	-0	-5	-6	-4	2	5	7	7	8	15	16	15	14	9	4
11	0	-0	-5	-7	-8	0	3	5	6	7	11	13	12	11	7	3
12	0	-0	-3	-6	-9	-2	1	3	4	5	8	11	9	8	5	2
13	0	-0	-1	-4	-7	-4	0	2	3	4	5	9	8	6	4	2
14	0	0	-0	-1	-4	-4	-0	1	2	3	4	7	6	4	3	1
15	0	0	0	-0	-2	-3	-0	0	1	2	3	5	5	3	1	1
16	0	0	0	-0	-1	-2	-1	0	0	1	2	3	3	2	1	0
17	0	0	0	0	-0	-2	-1	-0	0	1	1	2	2	1	0	0
18	0	0	0	0	-0	-1	-0	-0	0	0	1	1	2	1	0	0
19	0	0	0	0	-0	-1	-0	-0	0	0	0	1	1	0	0	0
20	0	0	0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0
21	0	0	0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0
22	0	0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0
23	0	0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0
24	0	0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0
25	0	0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0
26	0	0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0
27	0	0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0
28	0	0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0	0
29	0	0	-0	-0	-0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	-0	-0	-0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	-0	-0	-0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	-0	-0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	-0	-0	-0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	-0	-0	-0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	-0	-1	-0	0	0	0	1	0	0	0	0	0	0	0	0
36	0	-0	-0	0	0	0	0	1	0	0	0	0	0	0	0	0
37	0	-0	-0	0	0	1	1	2	0	0	0	0	0	0	0	0
38	0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0
39	0	0	1	2	2	1	0	0	0	0	0	0	0	0	0	0
40	0	0	2	3	3	3	0	0	0	0	0	0	0	0	0	0
41	-0	-1	1	4	4	7	11	5	2	0	0	0	0	0	0	0
42	-0	-1	1	4	9	13	10	5	2	0	0	0	0	0	0	0
43	-0	-2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
44	-0	-2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
45	-0	-1	2	3	0	0	0	0	0	0	0	0	0	0	0	0
46	0	1	4	11	0	0	0	0	0	0	0	0	0	0	0	0
47	-0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	-0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	-0	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	-0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 4.3 (Continued)

U AND UP

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2	0	19	12	13	19	24	30	43	0	0	0	0	0	0	0	0
3	0	54	27	22	22	24	26	34	10	0	0	0	0	-0	-0	-0
4	0	0	31	32	30	28	26	21	11	7	7	4	2	-1	-3	-2
5	0	0	26	29	28	27	29	26	14	10	13	7	5	1	-0	-0
6	0	0	29	31	29	27	28	25	17	13	12	10	6	2	0	0
7	0	0	34	32	26	26	25	23	17	15	15	13	8	3	1	0
8	0	0	37	36	34	28	25	23	18	17	15	12	8	4	2	0
9	0	0	35	36	36	28	24	22	19	17	16	15	10	5	3	1
10	0	0	29	31	31	28	24	21	18	16	15	13	9	6	3	1
11	0	0	20	24	25	25	22	19	16	15	13	11	8	5	3	1
12	0	0	11	15	13	21	19	16	15	13	12	9	6	4	2	1
13	0	0	0	8	13	17	17	14	12	11	9	7	5	3	1	0
14	0	0	0	0	8	11	13	12	10	9	8	6	4	2	1	0
15	0	0	0	0	4	7	9	9	7	7	5	4	3	1	0	0
16	0	0	0	0	0	6	6	6	5	5	4	3	2	1	0	0
17	0	0	0	0	0	2	3	4	4	4	3	2	1	0	0	0
18	0	0	0	0	0	1	2	3	3	2	2	1	1	0	0	0
19	0	0	0	0	0	0	1	2	2	2	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
21	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	-0	-0	-0	-0	0	0	0	0	0	0	0	0	0	0
27	0	0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0	0
28	0	0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0
29	0	0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0
30	0	0	-0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0
31	0	0	-0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0
32	0	0	-0	-0	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0
33	0	0	-0	-1	-1	-0	-0	-0	-0	0	0	0	0	0	0	0
34	0	0	-0	-1	-1	-1	-0	-0	-0	0	0	0	0	0	0	0
35	0	0	-3	-3	-2	-1	-0	-0	-0	0	0	0	0	0	0	0
36	0	0	-3	-4	-3	-2	-1	-0	-0	0	0	0	0	0	0	0
37	0	0	-6	-6	-3	-2	-1	-0	0	0	0	0	0	0	0	0
38	0	0	-10	-9	-5	-2	-2	0	0	0	0	0	0	0	0	0
39	0	0	-12	-8	-5	-3	-3	0	0	0	0	0	0	0	0	0
40	0	-0	-9	-12	-7	-3	-1	0	0	0	0	0	0	0	0	0
41	0	-9	-12	-12	-8	-2	-0	0	0	0	0	0	0	0	0	0
42	0	-12	-17	-15	-16	0	0	0	0	0	0	0	0	0	0	0
43	0	-20	-20	-17	-15	0	0	0	0	0	0	0	0	0	0	0
44	0	-24	-25	-20	-13	0	0	0	0	0	0	0	0	0	0	0
45	0	-29	-31	-23	-9	0	0	0	0	0	0	0	0	0	0	0
46	0	-41	-39	-47	0	0	0	0	0	0	0	0	0	0	0	0
47	0	-37	-42	-47	0	0	0	0	0	0	0	0	0	0	0	0
48	0	-36	-44	-47	0	0	0	0	0	0	0	0	0	0	0	0
49	0	-37	-47	-49	0	0	0	0	0	0	0	0	0	0	0	0
50	0	-43	-52	-53	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 4.3 (Continued)

	SEMAX	SEMIN	VMAX	UMIN	VMAX	VMIN
	.445	0.	.545	-.539	.388	-.274

EXIT CARD REACHED. LAST 6 DAYFILE MESSAGES ARE-  
 NEW FL = 006000.  
 SFL(134000)  
 RBR(A)  
 RCP(127157)  
 BREAKXX SG 16  
 SKIP TO EXIT. CARD  
 DEBUGGER READY.  
 CUS LEFT = 270  
 . 0815 7/19 MSS 0N PM. ALL OTHER SYSTEMS UP AND RUNNING.....0PNS 6211  
 EDIT!  
 BEGIN EDIT  
 ST0P;R!  
 NOW TYPE ^E0F (ST0P)  
 ^E0F!  
 JOB ENDED - DISCONNECTED

FIGURE 4.3 (Concluded)

## V SUMMARY

The objective of this manual is to provide the San Francisco District of the U.S. Army Corps of Engineers with the necessary information to access and run the DREGSIM simulation program. There are currently some site-dependent portions of the code that would have to be changed in order to use the model in areas other than San Pablo Bay. In addition, the inflows, wind velocities and depths in the Bay should be changed to be time-dependent variables. Experience has shown that there is an advantage to be gained by storing a two tidal-cycle simulation on the mass storage system and using it as the initial condition for subsequent simulations. This procedure would shorten the time required to set up a simulation run.

#### REFERENCES

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Appendix  
DREGSIM PROGRAM LISTING

Listing 1. DREGSIM Program

```

PROGRAM DREGSIM(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE5=INPUT,FILMPL
+ ,TAPE7,TAPE9,TAPE10,TAPE11,TAPE12)
C
C PROGRAM TO SIMULATE THE DISPERSION OF DISPOSED DREDGED MATERIALS
C
C SPRAGGS, LYNN D.
C STANFORD RESEARCH INSTITUTE
C
C
C CALL SETUP
C CALL HYDRO
C STOP
C END

```

Listing 2. SUBROUTINE MIAB

```

SUBROUTINE MIAB(MIABND,M,NMAX,MMAX)
DIMENSION MIABND(NMAX,MMAX), H(NMAX,MMAX)
DO 6 N=1,NMAX
DO 5 M=1,MMAX
MIABND(N,M)=0
5 CONTINUE
6 CONTINUE
NMAXH=MMAX - 1
MMAXH = MMAX - 1
DO 60 I = 2,NMAX
DO 50 J = 2,MMAX
HIJ=H(I-1,J-1)
HIPJ=H(I,J-1)
HIJP=H(I-1,J)
HIPJP=H(I,J)
IF(HIJ .GE. 0.01) GO TO 30
IF(HIPJ .GE. 0.01) GO TO 20
IF(HIJP .GE. 0.01) GO TO 10
MIABND(I,J) = 2
IF(HIPJP .LT. 0.01) MIABND(I,J) = 0
GO TO 50
10 CONTINUE
MIABND(I,J) = 3
IF(HIPJP .LT. 0.01) MIABND(I,J) = 4
GO TO 50
20 CONTINUE
MIABND(I,J) = 9
IF(HIPJP .LT. 0.01) MIABND(I,J) = 8
GO TO 50
30 CONTINUE
IF(HIPJ .GE. 0.01) GO TO 40
MIABND(I,J)=5
IF(HIJP .LT. 0.01) MIABND(I,J) = 6
GO TO 50
40 CONTINUE
MIABND(I,J) = 1
IF(HIJP .LT. 0.01) MIABND(I,J)=7
50 CONTINUE
60 CONTINUE
RETURN
END

```

# Listing 3. SUBROUTINE SETUP

```

SUBROUTINE SETUP
C      SET DIMENSIONS OF THE SYSTEM
C
C      DIMENSION MX(30),X(30000),L(30000),IFET(8)
C      EQUIVALENCE (X(1), L(1))
C      COMMON /FILES/ INFILE
C      COMMON /LOGIC / TAPEIN,TAPEOU,PRTCLS,RESTRY,PROT,METER
C      + ,NEWPRY
C      LOGICAL TAPEIN,TAPEOU,PRTCLS,RESTRY,PROT,METER
C      + ,NEWPRY
C
C      INTEGER SYSOIM
C      SYSOIM=30000
C
C***** NOTE
C      X,DELX,N,I AND V ARE IN COMPUTATIONAL EAST-WEST DIR.
C      Y,DELY,M,J AND U ARE IN COMPUTATIONAL NORTH-SOUTH DIR.
C
C      READ(5,5001) TAPEIN,TAPEOU,PRTCLS,RESTRY,PROT,METER
C      + ,NEWPRY
C      SETUPP = .TRUE.
C      REWIND 9
C      REWIND 10
C      IF(.NOT. TAPEIN) GO TO 5
C      INFILE=5
C      READ(9) MMAX,NMAX,MINDO,NINDO,NTRAC
C      GO TO 6
C
C      5 CONTINUE
C      READ(5,5000) INFILE
C      READ(INFILE,5000) MMAX,NMAX,MINDO,NINDO,NTRAC
C      MINDO=MINDO+1
C      NINDO=NINDO+1
C
C      6 CONTINUE
C      IF(.NOT. TAPEOU) GO TO 7
C      WRITE(10) MMAX,NMAX,MINDO,NINDO,NTRAC
C      IF(PRTCLS) WRITE(11) MMAX,NMAX,MINDO,NINDO,NTRAC
C
C      7 CONTINUE
C      NSECT = (NMAX+3)/2
C      IF(NMAX .LT. MMAX) NSECT = (MMAX+3)/2
C      NCARDENSTEP
C      MX(1)=1
C      LEN=NMAX*MMAX
C      LEN2 = NMAX*MMAX*INT(2,4)
C      DO 10 M=2,13
C      MMAX=M
C      MX(M)=MX(MM)+LEN
C
C      10 CONTINUE
C      LTOTAL=12*LEN+1200*MMAX+3*(MINDO+NINDO)+160
C      LTOTA2=2*(LEN+NSECT)+4*NMAX*MINDO+NINDO*LEN2
C      LTOT=LTOTAL+LTOTA2
C      IF(LTOT .GT. SYSOIM) GO TO 999
C
C***** ZERO REAL STORAGE
C
C      DO 20 I=1,LTOTAL

```

Listing 3(continued)

```

      X(I)=0.0
20    CONTINUE
C
C***** ZERO INTEGER STORAGE
C
      DO 25 I=1,LTOTA2
      L(I)=0
25    CONTINUE
C
      MX(14)=MX(13)+200
      MX(15)=MX(14)+200
      MX(16)=MX(15)+200
      MX(17)=MX(16)+600
      MX(18)=MX(17) + HMAX
      MX(19)=MX(18) + MINDO
      MX(20)=MX(19) + NINDO
      MX(21)=MX(20) + MINDO
      MX(22)=MX(21) + NINDO
      MX(23)=MX(22) + MINDO
      MX(24)=MX(23) + NINDO
      MX(25)=MX(24) + 160
      LEN2=HMAX+HMAX*2.4
      L1=LTOTAL+1
      L2=L1+LEN
      L3=L2+LEN
      L4=L3+NSECT
      L5=L4+NSECT
      L6=L5+MINDO
      L7=L6+NINDO
      L8=L7+HMAX
      L9=L8+HMAX
      L10=L9 +HMAX
      L11=L10 +HMAX
      L12=L11 + LEN2
      L13=L12 + 12
      L14=L13 + 80
C
C THESE CARDS NEEDED TO MAKE THE PROGRAM COMPATIBLE WITH
C CDC FORTRAN RUN COMPILER
C
      MX1 =MX(1 )
      MX2 =MX(2 )
      MX3 =MX(3 )
      MX4 =MX(4 )
      MX5 =MX(5 )
      MX6 =MX(6 )
      MX7 =MX(7 )
      MX8 =MX(8 )
      MX9 =MX(9 )
      MX10=MX(10)
      MX11=MX(11)
      MX12=MX(12)
      MX13=MX(13)
      MX14=MX(14)
      MX15=MX(15)
      MX16=MX(16)

```

Listing 3(concluded)

```

      MX17=MX(17)
      MX18=MX(18)
      MX19=MX(19)
      MX20=MX(20)
      MX21=MX(21)
      MX22=MX(22)
      MX23=MX(23)
      MX24=MX(24)
      MX25=MX(25)

C
C= HYDRO
C
      CALL HYDRO1(X(MX1),X(MX2),X(MX3),X(MX4),X(MX5),X(MX6)
+ ,X(MX7),X(MX8),X(MX9),X(MX10),X(MX11),X(MX12),X(MX13)
+ ,X(MX14),X(MX15),X(MX16),X(MX17),X(MX18),X(MX19)
+ ,X(MX20),X(MX21),X(MX22),X(MX23),X(MX24)
+ ,L(L1),L(L2),L(L3),L(L4),L(L5),L(L6),L(L7),L(L8),L(L9)
+ ,L(L11),L(L12),L(L13),L(L14),L(MX22),L(MX23)
+ ,NMAX,NMAX,NCARD,MINDO,NINDO,NSECT,NSTAT,NTRAC,LEN,LEN2)
      RETURN
      ENTRY HYDRO
      IF(.NOT. SETUP) GO TO 99

C
C***** CALCULATE VELOCITIES, ETC.
C
      CALL HYDRO2(X(MX1),X(MX2),X(MX3),X(MX4),X(MX5),X(MX6)
+ ,X(MX7),X(MX8),X(MX9),X(MX10),X(MX11),X(MX12),X(MX13)
+ ,X(MX14),X(MX15),X(MX16),X(MX17),X(MX18),X(MX19),X(MX20)
+ ,X(MX21),X(MX22),X(MX23),X(MX24)
+ ,L(L1),L(L2),L(L3),L(L4),L(L5),L(L6),L(L7),L(L8),L(L9)
+ ,L(L11),L(L12),L(L13),L(L14),L(MX22),L(MX23)
+ ,NMAX,NMAX,NCARD,MINDO,NINDO,NSECT,NSTAT,NTRAC,LEN,LEN2)
      RETURN
99  CONTINUE
      WRITE(6,6001)
      CALL EXIT
999  CONTINUE
      WRITE(6,6002) LTOT,LTOT,LTOT
      CALL EXIT
      STOP

C
C
5000 FORMAT(8(7X,I3))
5001 FORMAT(40L2)
6000 FORMAT(* DIMENSION X(*,I6,*), L(*,I6,*)*)
6001 FORMAT(/*****ERROR---SETUP NOT CALLED---**)
      DATA SETUP /,FALSE./
6002 FORMAT(/* ----- ERROR ----- STORAGE CAPACITY EXCEEDED*/
+ ,6X,* DIMENSION X(*,I6,*), L(*,I6,*)*/6X,* SYSDIM=*,I6/)
      END

```

Listing 4. SUBROUTINE CHEZY

```

SUBROUTINE CHEZY(NMAX,MMAX,C,H)
  DIMENSION C(NMAX,MMAX),H(NMAX,MMAX)
C
  CON1=19.4
  CON2=35.0
  CON3=50.0
C
  NMAXM = NMAX = 1
  MMAXM = MMAX = 1
  DO 100 N = 1,NMAXM
    DO 50 M = 1,MMAXM
      HP=(H(N+1,M)+H(N,M)+H(N,M+1)+H(N+1,M+1))/4.0
      HP=HP+1.0
      CC=0.9*HP
      IF(CC .LT. 1.0) GO TO 49
      C(N+1,M+1)=CON1*ALOG(CC)+CON2
    GO TO 50
  49  CONTINUE
      TEMP=ARS(CC)
      C(N+1,M+1)=CON1*ALOG(TEMP)+CON2
  50  CONTINUE
  100 CONTINUE
      DO 200 N=1,NMAX
        DO 150 M=1,MMAX
          IF(C(N,M) .LT. CON2+10.0) C(N,M)=CON3
        150 CONTINUE
      200 CONTINUE
  RETURN
END

```

Listing 5. SUBROUTINE TIDINT

```

SUBROUTINE TIDINT(DATUM,TYME,LONGIT,TIDLEV,PHI,DELT)
C
  TIDLEV=0.0
  KOUNT = 0
  TOLD=0.0
  100 CONTINUE
    CALL TIDE(TYME,LONGIT,TIDLEV,PHI)
    TSO=TOLD+(TIDLEV-DATUM)
    IF(TSQ .LT. 0.0) GO TO 300
    TOLD=TIDLEV-DATUM
    TYME=TYME+DELT
    KOUNT=KOUNT + 1
    IF(KOUNT .GE. 100) GO TO 200
    GO TO 100
  200 CONTINUE
    WRITE(6,6000) TYME
    CALL EXIT
  300 CONTINUE
    RETURN
C
  6000 FORMAT(2X,'CANNOT FIND TIDE LEVEL AT',2X,F10.2)
  6001 FORMAT(2X,'TIDE LEVEL FOUND AT TYME=',F10.2,'TIDE=',F10.2)
  6002 FORMAT(* TIDE=',F10.2)
  6003 FORMAT(* SEARCHING FOR SLACK TIME*/ * MEAN SEA LEVEL=',F10.2
    + , * TYME, DELT=',2(1X,F10.2,1X))
  END

```

Listing 6. SUBROUTINE INIT1

```

SUBROUTINE INIT1(NMAX,MMAX,WPART,SOURCE,TYMEHR,CD
+ ,TYME,PRT,DLTT,NST,NSTP,NINDO,MINDO,S,SP,V,VP,U,UP,SE,SEP,C,H)
C
C*****
C
  DIMENSION S(NMAX,MMAX),SP(NMAX,MMAX),V(NMAX,MMAX),VP(NMAX,MMAX)
+ ,U(NMAX,MMAX),UP(NMAX,MMAX),SE(NMAX,MMAX),SEP(NMAX,MMAX)
+ ,C(NMAX,MMAX),H(NMAX,MMAX)
C
  COMMON /R19 / LATUDE, LONGIT, RHO, RHOP, WINDX, WINDY, YEAR, DAY, HOUR
+ , HH, DATUM, SEINV, G, DELX, DELY, DELT, HORIZX, HORIZY, DEPMAX
  COMMON /DATA1 / NMAX, MMAX, CONZER, ITRGO, AG, PI, RADS, WINDCO, UMIN
+ , UMAX, VMIN, VMAX, SEMIN, SEMAX, NM, MH
  LOGICAL PRT
  REAL LONGIT, LATUDE
C
C
C
  NMAX=MMAX = 1
  MMAX=MMAX = 1
  CONZER=0.0
  WPART=0.2E-04
  TYMEHR=0.0
  ITRGO=1
  RHO=2.0
  RHOP=3.0
  CD=1.0E-3
  SEINV=0.0
  AG=9.81
  TYME=0.0
  PRT=.TRUE.
  PI=3.141592654
  DLTT=0.0
  NST=0
  RADS=180.0/PI
  WINDCO=.0013*.0012
  NSTP=0
  UMIN=100.
  UMAX=-100.
  VMIN=100.
  VMAX=-100.
  SEMIN=100.
  SEMAX=-100.
  NM=NINDO=1
  MH=MINDO=1
C
  DO 6 M=1,MMAX
    DO 6 N=1,NMAX
      S(N,M)=CONZER
      SP(N,M)=CONZER
      V(N,M)=0.0
      VP(N,M)=0.0
      U(N,M)=0.0
      UP(N,M)=0.0
      SE(N,M)=0.0
      SEP(N,M)=0.0
      C(N,M)=0.0
      H(N,M)=0.0
    6 CONTINUE
C
C
  RETURN
  END

```

Listing 7. SUBROUTINE TIDEIN

```

SUBROUTINE TIDEIN(YEAR, DAY, HOUR, PRT)
C
COMMON /TIDES/ DECL, ANGS, ANGM, ANGE, RAD9, OMEGAE, OMEGAM, OMEGAS,
1  DISTH, DIST9
COMMON /FIRSTD/ YEAR1, DAY1, HOUR1, ANGLE8, ANGLEM, ANGLEE
COMMON /MO/ MONTH(12), MON(12)
LOGICAL PRT
C
C***** INITIALIZE TIDE GENERATION PARAMETERS
C
DATA MON / 4H JAN, 4H FEB, 4H MAR, 4H APR, 4H MAY, 4H JUNE
1  , 4H JULY, 4H AUG, 4H SEPT, 4H OCT, 4H NOV, 4H DEC /
DATA MONTH / 31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31 /
C
PI=3.141592654
RAD9=180.0/PI
DECL=23.5/RAD9
PHI=40.0/RAD9
DISTH=238862.0
DIST9=92830000.0
DELYE=YEAR-YEAR1
DAYE=365.2422*DELYE
DAYES=DAYE+DAY-DAY1
HOURS=DAYES*24.0-HOUR1+HOUR
OMEGAE=1.0/24.0*2.0*PI
OMEGAM=1.0/24.0/27.32*2.0*PI
OMEGAS=1.0/365.2422/24.0*2.0*PI
ANGE=HOURS*OMEGAE+ANGLEE
ANGM=HOURS*OMEGAM+ANGLEM
ANGS=HOURS*OMEGAS+ANGLES
ANGE=REDANG(ANGE)
ANGS=REDANG(ANGS)
ANGM=REDANG(ANGM)
IF(.NOT. PRT) RETURN
IYEAR=YEAR
IDAY=DAY
IHOUR=HOUR
XX=IHOUR
XX2=HOUR-IHOUR
XMIN=60.0*XX2
IMIN=XMIN
XY2=IMIN
SECX=(XMIN-XY2)*60.0
ISEC=SECX
RETURN
END

```

Listing 8. SUBROUTINE INIAL

```

SUBROUTINE INIAL(NMAX,MMAX,NIND,MINDO,NINDO,SEINV,C,H,NBD,MNBD
*,NORD,SE,SEP,KONVRT)
DIMENSION H(NMAX,MMAX),C(NMAX,MMAX),NRD(NIND),NOBD(NINDO)
*,MORD(MINDO),SE(NMAX,MMAX),SEP(NMAX,MMAX),KONVRT(NMAX)
DO 90 N=1,NMAX
DO 90 M=1,MMAX
SEP(N,M)=0.0
SE(N,M)=0.0
90 CONTINUE
C
C***** INITIALIZE SURFACE
C
NUM=1
100 IF(NUM.EQ.NIND) GO TO 120
NSRCH=NBD(NUM)/1000000
NF=NBD(NUM)/10000 NSRCH*100
MF=NRD(NUM)/100 NSRCH*10000 NF*100
LF=NBD(NUM) NSRCH*1000000 NF*10000 MF*100
NN=N-1
K=MF
DO 110 M=K,L
SEP(N,M)=SEINV
SE(N,M)=SEINV
110 CONTINUE
NUM=NUM+1
GO TO 100
120 CONTINUE
NA=1
130 IF(NA.EQ.MINDO) GO TO 150
NTOP=MORD(NA)
MM=NTOP/10000000
NTOP=NTOP - MM*10000000
M=NTOP/100000
NTOP=NTOP - M*100000
NRD=NTOP/1000
NTOP=(NTOP - NRD*1000)/10
DO 140 M=NRD,NTOP
SEP(N,M)=SEINV
SE(N,M)=SEINV
140 CONTINUE
NA=NA+1
GO TO 130
150 NA=1
160 IF(NA.EQ.NINDO) GO TO 180
MRIG=NOBD(NA)
NM=MRIG/10000000
MRIG=MRIG - NM*10000000
M=MRIG/100000
MRIG=MRIG - M*100000
MLEF=MRIG/1000
MRIG=(MRIG - MLEF*1000)/10
DO 170 M=MLEF,MRIG
SE(N,M)=SEINV
SEP(N,M)=SEINV
170 CONTINUE
NA=NA+1
GO TO 160
180 CONTINUE
RETURN
END

```

Listing 9. SUBROUTINE FIND

```

SUBROUTINE FIND(MIND,NIND,MMAX,NMAX,MINDO,NINDO,NSECT,NBD,MBO,H
+ ,MORD,NORD,SE,MIDRY)
DIMENSION NRD(NSECT),MRD(NSECT),M(NMAX,MMAX),MORD(MINDO)
+ ,NORD(NINDO),SE(NMAX,MMAX),MIDRY(NMAX,MMAX)
LOGICAL START
NMAX=MNMAX=1
MMAX=MNMAX=1
DO 1 J =1,NSECT
NRD(J)=0
1 MRD(J)=0
MIND = 1
NIND = 1
DO 2 N=2,NMAXM
START =.TRUE.
DO 3 M=2,MMAXM
IF(.NOT. START) GO TO 4
IF(MIDRY(N,M) .NE. 1) GO TO 3
ISAVE = M
NRD(NIND) = M*100 + NBD(NIND)
START =.FALSE.
GO TO 3
4 CONTINUE
IF(MIDRY(N,M) .EQ. 1) GO TO 5
ISAVE2 = M+1
NRD(NIND) = M+1 + NRD(NIND) + 10000*M
GO TO 6
5 CONTINUE
IF(M .NE. MMAXM) GO TO 3
ISAVE2 = M
NRD(NIND) = M + NRD(NIND) + 10000*M
6 CONTINUE
IF(ISAVE2-ISAVE .GE. 1) GO TO 7
NRD(NIND) = 0
START =.TRUE.
GO TO 3
7 CONTINUE
NIND = NIND + 1
START =.TRUE.
3 CONTINUE
2 CONTINUE
DO 12 M=2,MMAXM
START =.TRUE.
DO 13 N=2,NMAXM
IF(.NOT. START) GO TO 14
IF(MIDRY(N,M) .NE. 1) GO TO 13
ISAVE = N
MRD(MIND) = N*100 + MRD(MIND)
START =.FALSE.
GO TO 13
14 CONTINUE
IF(MIDRY(N,M) .EQ. 1) GO TO 15
ISAVE2 = N + 1
MRD(MIND) = N+1 + MRD(MIND) + 10000*N
GO TO 16
15 CONTINUE
IF(N .NE. NMAXM) GO TO 13
ISAVE2 = N
MRD(MIND) = N + MRD(MIND) + 10000*N
16 CONTINUE
IF(ISAVE2-ISAVE .GE. 1) GO TO 17
MRD(MIND) = 0
START =.TRUE.
GO TO 13

```

Listing 9 (concluded)

```

17  CONTINUE
    MIND = MIND + 1
    START = .TRUE.
13  CONTINUE
12  CONTINUE
    NUM = 1
100 IF(NUM, EQ, MIND) GO TO 300
    N = NBD(NUM)/10000
    MF = NBD(NUM)/100 = N*100
    L = NBD(NUM) - N*10000 = MF*100
    MFLEF = MF - 1
    LRIG = L + 1
    NA = 1
200 IF(NA, EQ, MIND) GO TO 210
    NB = NBD(NA)
    M1 = NB/10000000
    MR = NB - M1*10000000
    M = MR/100000
    MR = MR - M*100000
    NROT = MR/1000
    MR = MR - NROT*1000
    NTOP = MR/10
    MR = MR - NTOP*10
    NERN = MR
    IF(((N, GE, NROT), AND, (N, LE, NTOP)), AND, (MFLEF, EQ, M)) NBD(NUM) =
1  NBD(NUM) + 10000000
    IF(((N, GE, NROT), AND, (N, LE, NTOP)), AND, (LRIG, EQ, M)) NBD(NUM) =
1  NBD(NUM) + 1000000
    NA = NA + 1
    GO TO 200
210 NUM = NUM + 1
    GO TO 100
300 CONTINUE
    NUM = 1
101 IF(NUM, EQ, MIND) GO TO 301
    M = MBD(NUM)/10000
    NF = MBD(NUM)/100 = M*100
    L = MBD(NUM) = M*10000 = NF*100
    NROT = NF - 1
    LTOP = L + 1
    NA = 1
201 IF(NA, EQ, MIND) GO TO 211
    NB = NBD(NA)
    N1 = NB/10000000
    NR = NB - N1*10000000
    N = NR/100000
    NR = NR - N*100000
    MLEF = NR/1000
    NR = NR - MLEF*1000
    MRIG = NR/10
    NR = NR - MRIG*10
    NERN = NR
    IF(M, GE, MLEF, AND, M, LE, MRIG, AND, NROT, EQ, N) MBD(NUM) = MBD(NUM)
1  + 10000000
    IF(M, GE, MLEF, AND, M, LE, MRIG, AND, LTOP, EQ, N) MBD(NUM) = MBD(NUM)
1  + 1000000
    NA = NA + 1
    GO TO 201
211 NUM = NUM + 1
    GO TO 101
301 CONTINUE
    RETURN
20  FORMAT(1H1, 3X, 3HNUM, 6X, 3HNBD, 7X, 3HNRD)
21  FORMAT(1H , 2X, 14, 2X, 19, 1X, 19)
    END

```

Listing 10. SUBROUTINE HYDRO1

```

SUBROUTINE HYDRO1(SE,SEP,U,UP,V,VP,C,H,EPS,S,SP,WAP,DIAM
* ,WZER,WZERP,TRACER,F,BNDU,BNOV,QBNDU,QBNOV,TIMDLX,TIMDLY,TIDES
* ,MIABND,MIDRY,MRD,NRD,MORD,NORD,KONVRT,NH,NO,IWENT
* ,TITL,NPRINT,LOCSTA,MOLA,NOLA
* ,MMAX,NMAX,NCARD,MINDO,NINDO,NSECT,NSTAT,NTRAC,LEN,LEN2)
C
  INTEGER TITL
  DIMENSION DIAGL(110), DIAG(110), DIAGU(110), RHS(110)
C
C
  DIMENSION EPS(NMAX,MMAX),DIAM(200),WZER(200),WZERP(200)
* ,F(MMAX),SE(NMAX,MMAX),SEP(NMAX,MMAX),V(NMAX,MMAX)
* ,VP(NMAX,MMAX),U(NMAX,MMAX),UP(NMAX,MMAX),C(NMAX,MMAX)
* ,H(NMAX,MMAX),NO(NMAX),TRACER(200,3)
* ,WAP(NMAX,MMAX)
  REAL LONGIT,LATUDE,MSL
C
  LOGICAL PRT,TAPEIN,TAPEOU,PRCLS,RESTR,OPNUP,OPNLOW
* ,PROT,METER,GOFIND,TEL,NEWPR
* ,TESTING
  DIMENSION KONVRT(NMAX),NH(NMAX),TITL(12)
* ,NRD(NSECT),MRD(NSECT),MORD(MINDO),NOBD(NINDO)
* ,LOCSTA(NSTAT),IWENT(LEN2),MIABND(NMAX,MMAX),MIDRY(NMAX,MMAX)
* ,S(NMAX,MMAX),SP(NMAX,MMAX),RNDU(MINDO),RNOV(NINDO)
* ,QBNDU(MINDO),QBNOV(NINDO)
* ,TIMDLX(MINDO),TIMDLY(NINDO),TIDES(160),MOLA(MINDO),NOLA(NINDO)
C
  COMMON /FILES/ INFILE
  COMMON /DATA1 / NMAX,MMAX,CONZER,ITRGO,AG,PI,RADS,WINDCO,UMIN
* ,UMAX,VMIN,VMAX,SEMIN,SEMAX,NH,MM
  COMMON / R19 / LATUDE, LONGIT, RHOH, RHOP, WINDX, WINDY, YEAR, DAY, HOUR
* ,HHH, DATUM, SEINV, G, DELX, DELY, DELT, HORIZX, HORIZY, DEPMAX
  COMMON / I4 / MAXST, NI, INLET, IJUMP
  COMMON /LOGIC / TAPEIN, TAPEOU, PRCLS, RESTR, PROT, METER
* ,NEWPR
  COMMON /TIDES / T(10)
C
  COMMON / BNDXY / ULAM,VLAM,TIDMAX
C
  COMMON /PARAM/ UIJM,UIJP,UIJ,UIJ,UIPJ,VIJ,VIJP,VIJM,VIJ,VIJP
* ,VIJM,VIJP,UIJM,UIPJ,CIJ,CIJ,CIP,CIP,CIJ,CIJ,CIJ,CIJ
* ,HIMJ,HIMJP,HIMJ,HIPJ,HSEIP,HSEIP,HSEIP,HSEIP,HSEIP
* ,YSTRES,YSTRES,SEIJ,SEIJ,SEIJ,SEIJ,SEIJ,SEIJ
* ,CIJM,CIJM
C
C
C .....
C
  DATA ENTRY AND SETUP OF HYDRO PROGRAM
C .....
C
  GOFIND=.FALSE.
  HOURD=3600.0
  TIMEIN=HOURD
  G=9.81
  TESTING=.FALSE.
  URIG=50.0
  VRIG=50.0
  SERIG=50.0
  DEPTOL=0.05
  KOUNT3=0
  KOUNT4=0
  ULAM=1.0
  VLAM=1.0
  TIDMAX=1.0

```

Listing 10 (continued)

```

      CALL INIT1(NMAX,MMAX,WPART,SOURCE,TYMEHR,CD
      * ,TYME,PRT,DLTT,NST,NSTP,NINDO,MINDO,S,SP,V,VP,U,UP,SE,SEP,C,H)
C
      KOUNT2=0
      IF(.NOT. TAPEIN) GO TO 1
      READ(5,5007) REGIN,FINISH
C
C***** IF( BEGIN .LT. 0.0) THEN BEGIN AT END OF TAPE
C      IF(FINISH .LT. 0.0) THEN READ MAXST AND NOUT TO CONTROL EXIT
C
      READ(9) TITL
      CALL DATARD
      READ(9) MORD,QBNDU,TIMDLX,NOBD,QBNDV,TIMOLY
      READ(9) T
      IF(PROT) GO TO 3342
      IF(PRTCLS .AND. .NOT. RESTRY) GO TO 500
      READ(5,5002) MAXST,NOUT
      READ(5,5007) DELT,WINDX,WINDY
      READ(5,5007) SOURCE
      READ(5,5002) IJDUMP
      READ(5,5001) (MORD(M),QBNDU(M),TIMDLX(M),M=1,MM)
      READ(5,5001) (NORD(M),QBNDV(M),TIMOLY(M),M=1,NM)
      CALL TAPDAT(NMAX,MMAX,TYME,BEGIN,SEP,UP,VP,H,C,EPS,NSTP)
      IF(.NOT. NEWPRT) GO TO 3341
C
C***** NEWPRT=.T. INPUT NEW PARTICLE INFORMATION
C
      ITRGO=3
      GO TO 505
3341 CONTINUE
      ITRGO=1
      DO 3336 N=1,NMAX
      DO 3335 M=1,MMAX
      SE(N,M)=SEP(N,M)
      V(N,M)=VP(N,M)
      U(N,M)=UP(N,M)
3335 CONTINUE
3336 CONTINUE
C
C***** INPUT TRACER DATA AND ALL MAX/MIN
C
      READ(9) UMAX,UMIN,VMAX,VMIN,SEMAX,SEMIN
      IF(NEWPRT) GO TO 3342
      READ(9) NTRAC,TRACER
3342 CONTINUE
C
C # PRNTR PRINT CONTENTS OF MAGNETIC RESTART TAPE
C
      IF(PROT) CALL PRNTR(FINISH,REGIN,TYME,NST,MMAX
      * ,NMAX,KONVRT,SEP,VP,UP,H,C,EPS)
C
      PHI=LATUDE/RADE
      GO TO 3340
1 CONTINUE
C
C***** INPUT SITE DESCRIPTORS
C
      READ(INFILE,5006) (TITL(J),J=1,12)
      READ(INFILE,5007) LATUDE,LONGIT,YEAR,DAY,HOOR
      READ(INFILE,5007) DELX,DELY,DELT,WINDX,WINDY
      READ(INFILE,5007) HMM,DATUM,SOURCE
      READ(INFILE,5002) MAXST,NI,INLET,IJDUMP,NOUT
      READ(INFILE,5001) (MORD(M),QBNDU(M),TIMDLX(M),M=1,MM)
      READ(INFILE,5001) (NORD(N),QBNDV(N),TIMOLY(N),N=1,NM)
      KOUNT1=0
      IF(METER) GO TO 6

```

Listing 10 (continued)

```

C***** CONVERT FEET TO METERS
C
  DATUM=DATUM*.3048
  DELX=DELX*.3048
  DELY=DELY*.3048
  MM=MM*.3048
3340 CONTINUE
  IF(METER) GO TO 10
  WINDX=WINDX*.3048
  WINDY=WINDY*.3048
  IF(MINDO .LT. 2) GO TO 3
    DO 2 M=1,MM
      BNDU(M)=QRNDU(M)
      QRNDU(M)=QRNDU(M)*.3048*.3048*.3048
    CONTINUE
  2
  3 CONTINUE
  IF(MINDO .LT. 3) GO TO 5
    DO 4 N=1,NM
      BNDV(N)=QRNDV(N)
      QRNDV(N)=QRNDV(N)*.3048*.3048*.3048
    CONTINUE
  4
  5 CONTINUE
  IF(TAPEIN) GO TO 10
  6 CONTINUE
C
  DO 7 N=1,NMAX
    DO 7 M=1,MMAX
      EPS(N,M)=1.0
    CONTINUE
  7
C
C
C***** INITIALIZE TIDE GENERATOR
C
  TYME=HOUR
  PHI=LATITUDE/RADS
  CALL RESET
  CALL TIDEIN(YEAR,DAY,HOUR,PRT)
  DLT = DELT/3600.0
  CALL TIDINT(DATUM,TYMEHR,LONGIT,TIDLEV,PHI,DLT)
C
C = DEPTH
C
  CALL DEPTH(NMAX,MMAX,H,DATUM,METER,DEPMAX,INFILE)
C
10 CONTINUE
  XM=MMAX*2
  YN=MMAX*2
  HORIZX=DELX*XM
  HORIZY=DELY*YN
C
C = DRYCEL
C
  CALL DRYCEL(SE,H,MIDRY,NMAX,MMAX,GOFIND)
C
  SURVEL=(G*DEPMAX)*.5
  COURNT=DELT*SURVEL/DELX
  DELTOK=DELX/SURVEL*.96
  DELTS=DELT
  SCALET=DELT/DELTOK*.5
  DXT=DELX
  DYT=DELY
  IF(SCALET .LT. 1.0) SCALET=1.0
  SOURCE=SOURCE/DXT/DYT

```

Listing 10 (continued)

```

C = FIND
C
  CALL FIND(MIND,NIND,MMAX,NMAX,MINDO,NINDO,NSECT,NBD,MBD,H,MORD
+ ,NOBD,SEP,MIDRY)
C
  IF(TAPEIN) GO TO 11
C
C = INIAL
C
  CALL INIAL(NMAX,MMAX,NIND,MINDO,NINDO,SEINV,C,H,NBD,MOBD
+ ,NOBD,SE,SEP,KONVRT)
C
11  CONTINUE
    IF(.NOT. TAPEOU) GO TO 12
    WRITE(10)TITL
    WRITE(11) TITL
    WRITE(12) TITL
C
C = DATAWT
C
  CALL DATAWT
C
  WRITE(10)MOBD,QBNDU,TIMDLX,NORD,QBNDV,TIMDLV
  WRITE(10) T
12  CONTINUE
C
  PFI=PI*SIN(PHI)/21600./SCALET
C
  DO 5 M=1,MMAX
    F(M)=PFI
  5  CONTINUE
C
  WIND=WINDX**2+WINDY**2
  IF(WIND.LT. 1.0E-30)WIND=1.0E-30
  WIND=SQRT(WIND)
  TAUW=WINDCO*WINDX+WIND
  TAUW=WINDCO*WINDY+WIND
  XSTRES=TAUX
  YSTRES=TAUY
C
C = PRNT
C
  CALL PRNT(NMAX,MMAX,NCARD,MINDO,NINDO,NSECT,NSTAT,NTRAC
+ ,LEN,LEN2,NT,INLET,IJDUMP,MOBD
+ ,NORD,TITL,H,NH,C,MAXST,BNDU,BNDV)
C
  DELX=DELX+SCALET
  DELY=DELY+SCALET
  TIDMAX=TIDMAX+SCALET
  AT=DELT
  AL=DELX
  C1=AT*AG/AL
  C2=AT/AL
  C3=AT/4.0
  C4=A,0.AT*AG
  IF(TAPEIN) GO TO 14
  IF(PRTCLS) GO TO 505
13  CONTINUE
C
C = CHEZY
C
  CALL CHEZY(NMAX,MMAX,C,H)
C
14  CONTINUE

```

Listing 10 (continued)

```

CALL MIAB(MIABND,M,NMAX,MMAX)
IP=0
ISTEP=2
IF(TAPEIN)NSTP=TYME/DELT
DLMIN=DELT/60.0
NUM = 1
TIMDMX = 0.0
DO 20 M=1,MM
  IF(TIMDMX.LT. TIMDLX(M)) TIMDMX=TIMDLX(M)
20 CONTINUE
C
DO 30 N=1,NM
  IF(TIMDMX.LT. TIMDLY(N)) TIMDMX=TIMDLY(N)
30 CONTINUE
C***** NUMTID GIVES MAXIMUM DELAY NECESSARY
NUMTID=TIMDMX/DLMIN+1
DO 40 M=1,MM
  MD=TIMDLX(M)/DLMIN
  MDLA(M)=MD+1
40 CONTINUE
C
DO 50 N=1,NM
  ND=TIMDLY(N)/DLMIN
  NDLA(N)=ND+1
50 CONTINUE
C
DO 55 I=1,NUMTID
  TIDES(I)=SEINV
55 CONTINUE
RETURN
C
C*****-----*****
C
C      SIMULATION PORTION OF HYDRO CALCULATION
C
C*****-----*****
C
C      ENTRY HYDRO2
C
C***** COMPUTE UP AND SEP ON ROW N. FIRST HALF TIMSTP
C
88 ISTEP=1
C
C***** CALCULATE VELOCITY AT LAND BOUNDARY BASED ON
C      FLOW VOLUME AND DISTANCE FROM OCEAN INLET
C
CALL UELBND(MORB,MINDO,RNDU,QBNDU,H,SE,NMAX,MMAX,DXT)
CALL VELBND(NOBD,NINDO,BNDV,QBNDV,H,SE,NMAX,MMAX,DYT)
NST =NST +1
K=2*NST-1
IF(FINISH.GT. 0.0) GO TO 89
IF(NST.GT. MAXST) GO TO 997
GO TO 90
89 CONTINUE
IF(TYME.GT. FINISH) GO TO 997
90 CONTINUE
AT=DELT
TYME=TYME+AT
C
C***** DLT IS TIME-STEP IN HOURS
C      DTMIN IS TIME-STEP IN MIN.
C
DLT=AT/3600.0
DTMIN = AT/60.0

```

Listing 10 (continued)

```

      CALL BNDY(SE,NMAX,MMAX,MINDO,NTNDO,MOBD,NORD,INLET,K,DLT,LONGIT
      + ,PHI,DATUM,WATLEV,TYMEHR,U,V,BNDU,RNDV,DELY,DELY)
C
C 6782 FORMAT(* WATLEV=,E12.5 )
C
C***** SHIFT OLD TIDES
C
      DO 91 K = 2,NUMTID
      KM = K - 1
      TIDES(KM) = TIDES(K)
91    CONTINUE
      TIDES(NUMTID) = WATLEV
      WATLEV=WATLEV*SCALE7
C
C***** SET BOUNDARY CONDITIONS
C
      CALL UBND(SE,U,V,NMAX,MMAX,MOBD,MINDO,BNDU,TIDES,NUMTID,MDLA)
C
C***** U AND ETA AT M+1/2
C
96    NUM = 1
      CALL ZERO(NMAX,MMAX,UP)
      CALL ZERO(NMAX,MMAX,SEP)
100   IF(NUM.EQ.NIND) GO TO 190
      NSRCH = NBD(NUM)/1000000
      N = NBD(NUM)/10000 = NSRCH*100
      MF = NBD(NUM)/100 = NSRCH*10000 = N*100
      L = NBD(NUM) = NSRCH*1000000 = N*10000 = MF*100
      MFF = MF*1
      NNN=N+1
      NN = N = 1
      IT=1
C
C***** NSRCH=1 THEN OPEN BOUNDARY RIGHT OR BOTTOM
C
      NSRCH=10 THEN OPEN BOUNDARY LEFT OR TOP
C
      NSRCH=11 BOTH 10 AND 1
C
      OPNUP=.FALSE.
      OPNLOW=.FALSE.
      JFIRST=MF
      JLAST=L
      IF(NSRCH.EQ. 10 .OR. NSRCH.EQ. 11) OPNLOW=.TRUE.
      IF(NSRCH.EQ. 1 .OR. NSRCH.EQ. 11) OPNUP=.TRUE.
      IF(OPNUP) JLAST=JLAST+1
      I=N
      KP=1
      J=JFIRST
C
C***** WORK ON LINE I FOR J=JFIRST TO JLAST
C
59    CONTINUE
C
C= SETVAR
C
      IP=I+1
      IM=I-1
      JM=J-1
      JP=J+1
      SEIJ=SE(I,J)
      SEIJP=SE(I,JP)
      SEIJM=SE(I,JM)
      SEIPJ=SE(IP,J)
      SEIMJ=SE(IM,J)

```

Listing 10 (continued)

```

      UIJ=U(I,JM)
      UIJM=U(I,J=2)
      UIJP=U(I,J)
      UIMJ=U(IM,JM)
      UIPJ=U(IP,JM)
      VIJ=V(I,J)
      VIJM=V(I,JM)
      VIMJ=V(IM,J)
      VIMJM=V(IM,JM)
C
      HIJ=H(I,J)
      HIJM=H(I,JM)
      HIMJ=H(IM,J)
      HIMJM=H(IM,JM)
C
      CIJ=C(I,JM)
      CIJP=C(I,J)
C
      HSEIJM=(HIJM+HIMJM+SEIJM+SEIJJ)*0.5
      HSEIJP=(HIJ+HIMJ+SEIJ+SEIJP)*0.5
      HSEIMJ=(HIMJ+HIMJM+SEIMJ+SEIJJ)*0.5
      HSEIPJ=(HIJ+HIJM+SEIJ+SEIPJ)*0.5
C
C
      BNDLOW=0.0
      BNDUP=0.0
      COEF3=C2
      COEF4=C2
      COEF1=C1
      COEF2=C1
      USQ=UIJ*UIJ
      XSTRES=TAUX
C
      IF(J.EQ.JFIRST) GO TO 60
      IF(J.EQ.JLAST) GO TO 70
      GO TO 61
60      CONTINUE
C
C***** FIRST CELL CHECK FOR OPEN BOUNDARY
C
      IF(.NOT.OPNLOW) GO TO 75
C
C***** OPEN LOWER BOUNDARY
C
      BNDLOW=-C1*SEIJM
      COEF1=0.0
      UIJM=UIJ
      VIJM=0.0
      VIMJM=0.0
61      CONTINUE
      CALL SETBNX(NMAX,MMAX,I,J,MIDRY,V)
C
64      CONTINUE
      OXJP=0.0
      HSEIJM=(HIJM+HIMJM+SEIJ+SEIJM)*0.5
      VIJ2=0.25*(VIJ+VIMJ+VIJM+VIMJM)
      CORIX=F(J)*VIJ2
      VSG=VIJ2*VIJ2
      UV=(USQ+VSG)**0.5
      CSQ=0.25*(CIJ+CIJP)**2
      IF(HSEIJM.LT.DEPTOL) GO TO 80
      UPTOP=AG*UIJ*UV
      UNDER=HSEIJM*CSQ
      RXJP=UPTOP/UNDER
      FXJP=XSTRES/HSEIJM
      GO TO 80
70      CONTINUE

```

Listing 10 (continued)

C  
C\*\*\*\*\* LAST CELL CHECK FOR OPEN BOUNDARY

C  
IF(,NOT, OPNUP) GO TO 76

C  
C\*\*\*\*\* OPEN UPPER BOUNDARY

C  
XSTRES=0.0  
COEFU=0.0  
SEIJP=SEIJ  
SEIJP=SEIJ  
HSEIJP=(HIJ+HIMJ+SEIJP+SEIJ)\*0.5  
BNDUP=DELX\*HSEIJP\*UIJP/DELX  
VIJ=0.0  
VIMJ=0.0  
GO TO 61  
75 CONTINUE

C  
C\*\*\*\*\* SOLID SOUTH BOUNDARY

C  
BNDLOW=0.0  
RHS(1)=0.0  
DIAGU(1)=0.0  
DIAGL(1)=0.0  
DIAG(1)=1.0  
UIJ=0.0  
VIJM=VIJ  
VIMJM=VIMJ  
SEIJM=SEIJ  
HSEIJM=(HIJM+HIMJM+SEIJM+SEIJ)\*0.5  
UIJM=UIJP  
GO TO 61  
76 CONTINUE

C  
C\*\*\*\*\* SOLID NORTH BOUNDARY

C  
UIJ=0.0  
VIJM=VIJ  
VIMJM=VIMJM  
UIJM=UIJM  
SEIJP=SEIJ  
HSEIJP=(HIJ+HIMJ+SEIJ+SEIJP)\*0.5  
GO TO 61  
80 CONTINUE

C  
C\*\*\*\*\* UPSTREAM CONVECTION CALCULATION

C  
UUP=(UIJP+UIJ)\*0.5  
UXJP=UIJ  
IF(UUP ,LT, 0.0) UXJP=UIJP  
UUM=(UIJ + UIJM)\*0.5  
UXJM=UIJ  
IF(UUM ,GT, 0.0) UXJM=UIJM  
DUUDX=(UUP+UXJP+UUM+UXJM)/DELX  
VUP=(VIJ+VIJM)\*0.5  
VUM=(VIMJ+VIMJM)\*0.5  
UYJP=UIJ  
IF(VUP ,LT, 0.0) UYJP=UIPJ  
UYJM=UIJ  
IF(VUM ,GT, 0.0) UYJM=UIMJ  
DUVDY=(VUP+UYJP+VUM+UYJM)/DELY

Listing 10 (continued)

```

      IDIR=1
C
      CALL DIFFUS(NMAX,MMAX,I,J,DELX,DELY,EPS,U,V,DXJP,IDIR)
      KOUNT=KP+1
      DIAGL(KOUNT)=COEF3*MSEIJM
      DIAG(KOUNT)=1.0
      DIAGU(KOUNT)=COEF4*MSEIJP
      ZETA=SEIJ-C2*(VIJ*MSEIPJ-VIMJ*MSEIMJ)
      RHS(KOUNT)=ZETA*BN DUP
85      CONTINUE
      IF(J.EQ.JFIRST.AND..NOT.OPNLOW) GO TO 86
      DIAGL(KP)=COEF1
      DIAG(KP)=1.0
      DIAGU(KP)=COEF2
      ZETA=AT*(CDRIX-RXJP+FXJP+DXJP-DUUDX-DUVDY)
      RHS(KP)=UIJ+ZETA*BN DLOW
      GO TO 87
86      CONTINUE
      DIAGL(KP)=0.0
      DIAGU(KP)=0.0
      DIAG(KP)=1.0
      RHS(KP)=0.0
87      CONTINUE
      KP=KOUNT+1
C
C***** CHECK FOR MORE CELLS
C
      IF(J.EQ.JLAST) GO TO 99
      J=J+1
      GO TO 59
99      CONTINUE
C
C = TDIAG
C
      CALL TDIAG(DIAGL,DIAG,DIAGU,RHS,KOUNT)
C
      K2=1
      JL=JLAST
      DO 101 J=JFIRST,JL
      JM=J-1
      J=JM+1
      TEMP=DIAG(K2)
      IF(TEMP.GT.URIG) TEMP=URIG
      IF(TEMP.LT.-URIG) TEMP=-URIG
      UP(I,JM)=TEMP
      K2=K2+1
      TEMP=DIAG(K2)
      IF(TEMP.GT.SERIG) TEMP=SERIG
      IF(TEMP.LT.-SERIG) TEMP=-SERIG
      SEP(I,J)=TEMP
      K2=K2+1
101      CONTINUE
C
      NUM = NUM + 1
      GO TO 100
190 CONTINUE
C
C = RNDY
C
      CALL UBND(SEP,UP,V,NMAX,MMAX,MORD,MINDO,RNDU,TIDES,NUMTID,MDLA)
C
      IF(.NOT.TESTING) GO TO 203

```

Listing 10 (continued)

```

C      CALL EXTND(NMAX,MMAX,MIDRY,SEP,IP,V)
C
C 203 CONTINUE
C   DRYCEL
C      CALL DRYCEL(SEP,H,MIDRY,NMAX,MMAX,GOFIND)
C
C      COMPUTE VP ON COLUMN M (FIRST HALF TIMESTEP)
C
C      NUM=1
C      CALL ZERO(NMAX,MMAX,VP)
201  IF(NUM.EQ. MIND) GO TO 270
      MSRCH=MRD(NUM)/1000000
      M=MRD(NUM)/10000      MSRCH=100
      NF=MRD(NUM)/100      MSRCH=10000      M=100
      L=MRD(NUM)           MSRCH=1000000=M*10000      NF=100
      J=M
      IFIRST=NF-1
      ILAST=L
      DO 260 I=IFIRST,ILAST
C
C   SETVAR
C      CALL SETVAR(NMAX,MMAX,UP,V,SE,C,H,I,J)
C
C      IF(I.EQ. IFIRST) GO TO 210
C      IF(I.EQ. ILAST) GO TO 220
C      GO TO 230
C
C***** CELL CALCULATION
C
C 205 CONTINUE
      VVP=(VIJ+VIPJ)*0.5
      VVM=(VIJ+VIMJ)*0.5
      UVP=(UIJ+UIPJ)*0.5
      UVM=(UIJ+UIPJ)*0.5
      VVIP=VIJ
      IF(VVP.LT. 0.0) VVIP=VIPJ
      VVIM=VIJ
      IF(VVM.GT. 0.0) VVIM=VIMJ
      VVIP=VIJ
      IF(UVP.LT. 0.0) VVIP=VIPJ
      VVIM=VIJ
      IF(UVM.GT. 0.0) VVIM=VIMJ
      DUVDY=(VVP+VVIP-VVM+VVIM)/DELY
      DUVDX=(UVP+VVIP-UVM+VVIM)/DELY
      UIJ2=(UIJ+UIPJ+UIPJ+UIJM)*0.25
C
C***** HSEIPJ MUST BE CLOSE TO ZERO
C
      USQ=UIJ2*UIJ2
      VSQ=VIJ*VIJ
      UV=(USQ+VSQ)**0.5
      CSQ=((CIPJ+CIJ)**2)/4.0
      UNDER=HSEIPJ*CSQ*2.0
      UPTOP=AG*UV
      RYIP=0.0
      FYIP=0.0
C
C      IF(HSEIPJ.LE. DEPTOL) GO TO 250
C
C      RYIP=UPTOP/UNDER
C
C      FYIP=TAUY/HSEIPJ
206 CONTINUE

```

Listing 10 (continued)

```

C      CORIY=F(J)*UIJ2
C***** DIFFUSION TO BE ADDED HERE AS DYIP
C      IDIR=2
C      CALL DIFFUS(NMAX,MMAX,I,J,DELY,DELY,EPS,UP,V,DYIP,IDIR)
C      DSEDY=AG/DELY*(SEIPJ-SEIJ)
C      RHSY=VIJ+AT*(DYIP+FYIP-CORIY-DVVVY-DHVVY-VIJ+HYIP-DSEDY)
C      DENDM=1.0
C
C***** VP CALCULATION
C      TEMP=RHSY/DENDM
C      IF(TEMP.GT. VRIG) TEMP=VRIG
C      IF(TEMP.LT. -VRIG) TEMP=-VRIG
C      VP(I,J)=TEMP
C      GO TO 250
C
210      CONTINUE
C*****FIRST CELL. CHECK FOR OPEN BOUNDARY
C      IF(MSRCH.LT. 10) GO TO 250
C      CIPJ=CIJ
C      VIPJ=VIJ
C      UIPJ=0.0
C      UIPJ=0.0
C      GO TO 230
220      CONTINUE
C***** LAST CELL. CHECK FOR OPEN BOUNDARY
C      IF(MSRCH.NE. 1 .AND. MSRCH.NE. 11) GO TO 250
C      CIPJ=CIJ
C      VIPJ=VIJ
C      UIPJ=0.0
C      UIPJ=0.0
C      SEIPJ=SEIJ
C      GO TO 230
230      CONTINUE
C***** IS SOUTH CELL DRY
C      IF(MIDRY(I,J-1).NE. 2) GO TO 235
C      SEIJM=SEIJ
C      HSEIJM=0.0
C      VIJM=-VIJ
C      CIJM=CIJ
235      CONTINUE
C***** IS NORTH CELL DRY
C      IF(MIDRY(I,J+1).NE. 2) GO TO 237
C      SEIJP=SEIJ
C      HSEIJP=(HIJ+HIMJ+SEIJ+SEIJP)*0.5
C      VIJP=-VIJ
C      CIJP=CIJ
237      CONTINUE
C      GO TO 205
250      CONTINUE
260      CONTINUE
      NUM = NUM +1

```

Listing 10 (continued)

```

      GO TO 201
270  CONTINUE
C
C
C = SHIFT
C
      CALL SHIFT(NMAX,MMAX,U,V,SE,UP,VP,SEP)
C
      TYME=TYME+DELT
C
C = BNDRY
C
      CALL BNDRY(SE,NMAX,MMAX,MINDO,MINDO,MORD,NORD,INLET,K,DLT,LONGIT
+ ,PHI,DATUM,WATLEV,TYMEHR,U,V,BNDU,BNDV,DELY,DELY)
C
      WATLEV=WATLEV+SCALET
      CALL VBND(SE,U,V,NMAX,MMAX,NORD,MINDO,BNDV,TIDES,NUMTID,NDLA)
      K=2*NST
C
C      COMPUTE VP AND SEP ON COLUMN M ( SECOND HALF TIMESTEP )
C
      NUM=1
      CALL ZERO(NMAX,MMAX,SEP)
      CALL ZERO(NMAX,MMAX,VP )
301  IF(NUM,EQ,MIND) GO TO 390
      MSRCH =MBD(NUM)/1000000
      M   =MBD(NUM)/10000   =MSRCH*100
      NF   =MBD(NUM)/100    =MSRCH*10000   =M*100
      L    =MBD(NUM)        =MSRCH*1000000=M*10000 = NF*100
      MM=M-1
C
C***** NSRCH=1 THEN OPEN BOUNDARY RIGHT OR BOTTOM
C***** NSRCH=10 THEN OPEN BOUNDARY LEFT OR TOP
C***** NSRCH=11 BOTH 10 AND 1
C
C***** FIRST SOLVE FOR VP AND SEP IMPLICITLY
C
      OPNUP=.FALSE.
      OPNLOW=.FALSE.
      IF(MSRCH.EQ. 10 .OR. MSRCH.EQ. 11) OPNLOW=.TRUE.
      IF(MSRCH.EQ. 1 .OR. MSRCH.EQ. 11) OPNUP=.TRUE.
      IFIRST=NF
      ILAST=L
      JM=M
      KP=1
      I=IFIRST
      IF(OPNUP) ILAST=ILAST+1
C
C***** WORK ON LINE J FOR I=IFIRST TO ILAST
C
159  CONTINUE
C
C = SETVAR
C
      IP=I+1
      IM=I-1
      JM=J+1
      JP=J+1
C
      SEIJ=SE(I,J)
      SEJP=SE(I,JP)
      SEJM=SE(I,JM)
      SEIPJ=SE(IP,J)
      SEIMJ=SE(IM,J)

```

Listing 10 (continued)

```

      VIJ=V(IM,J)
      VIMJ=V(I=2,J)
      VIPJ=V(I,J)
      VIJM=V(IM,JM)
      VIJP=V(IM,JP)
      UIJ=U(I,J)
      UIMJ=U(IM,J)
      UIJM=U(I,JM)
      UIMJM=U(IM,JM)
C
      HIJ=H(I,J)
      HIJM=H(I,JM)
      HIMJ=H(IM,J)
      HIMJM=H(IM,JM)
C
      CIJ=C(IM,J)
      CIPJ=C(I,J)
C
      HSEIJM=(HIJM+HIMJM+SEIJM+SEIJ)*0.5
      HSEIJP=(HIJ+HIMJ+SEIJ+SEIJP)*0.5
      HSEIMJ=(HIMJ+HIMJM+SEIMJ+SEIJ)*0.5
      HSEIPJ=(HIJ+HIJM+SEIJ+SEIPJ)*0.5
C
C
      BNDLOW=0.0
      BNDUP=0.0
      COEF1=C1
      COEF2=C1
      COEF3=C2
      COEF4=C2
      VSG=VIJ*VIJ
      YSTRRES=TAUY
C
C
      IF(I.EQ. IFIRST) GO TO 160
      IF(I.EQ. ILAST) GO TO 170
      GO TO 161
160      CONTINUE
C
C***** FIRST CELL CHECK FOR OPEN BOUNDARY
C
      IF(.NOT. OPNLOW) GO TO 175
      VIMJ=VIJ+2.0 = VIPJ
C
C***** OPEN LOWER BOUNDARY
C
      BNDLOW=C1+SEIMJ
      COEF1=0.0
      UIJ=0.0
      UIMJ=0.0
161      CONTINUE
      IF(MIDRY(I,J+1).EQ. 2) GO TO 165
162      CONTINUE
      IF(MIDRY(I,J-1).EQ. 2) GO TO 166
C
164      CONTINUE
      HSEIMJ=(HIMJ+HIMJM+SEIJ+SEIMJ)*0.5
      DIP=0.0
      UI2J=0.25*(UIJ+UIMJ+UIMJM+UIMJM)
      CORIV=F(J)*UI2J
      USQ=UI2J*UI2J
      VUS=(VSG+USQ)**.5
      CSG=0.25*(CIJ+CIPJ)**2

```

Listing 10 (continued)

```

IF(HSEIMJ .LT. DEPTOL) GO TO 160
UPTOP=AG*VIJ*VU
UNDER=HSEIMJ*CSQ
RYIP=UPTOP/UNDER
PYIP=YSTRES/HSEIMJ
GO TO 160
165 CONTINUE
C
C***** NORTH ADJACENT CELL DRY
C
      UIJ=0.0
      UIPJ=0.0
      VIJP=-VIJ
      SEIJP=SEIJ
      CIJP=CTJ
      HSEIJP=(HIJ+HIMJ+SEIJ+SEIJP)*0.5
      IF(HSEIJP .LT. 0.0) HSEIJP=0.0
      GO TO 162
166 CONTINUE
C
C***** SOUTH ADJACENT CELL DRY
      VIJM=-VIJ
      UIJM=0.0
      SEIJM=SEIJ
      CIJM=CTJ
      HSEIJM=(HIJM+HIMJM+SEIJ+SEIJM)*0.5
      IF(HSEIJM .LT. 0.0) HSEIJM = 0.0
      GO TO 164
170 CONTINUE
C
C***** LAST CELL. CHECK FOR OPEN BOUNDARY
C
C
      IF(.NOT. OPNUP) GO TO 176
C***** OPEN UPPER BOUNDARY
C
      UIMJ=0.0
      UIMJM=0.0
      SEIPJ=SEIJ
      HSEIPJ=(HIJ+HIJM+SEIJ+SEIPJ)*0.5
      BNDUP=DELT*HSEIPJ*VIPJ/DELY
      COEF4=0.0
      GO TO 161
175 CONTINUE
C
C***** DRY EAST BOUNDARY
C
      RMS(1)=0.0
      DIAGU(1)=0.0
      DIAGL(1)=0.0
      DIAG(1)=1.0
      VIJ=0.0
      UIMJ=-UIJ
      UIMJM=-UIJM
      SEIMJ=SEIJ
      HSEIMJ=(HIMJ+HIMJM+SEIMJ+SEIJ)*0.5
      VIMJ=-VIPJ
      GO TO 161
176 CONTINUE

```

Listing 10 (continued)

```

C***** DRY WEST BOUNDARY
C
      VIJ=0.0
      VIPJ=VIMJ
      UIJ=0.0
      UIJM=UIJ
      SEIPJ=SEIJ
      MSEIPJ=(HIJ+HIJM+SEIJ+SEIPJ)*0.5
      GO TO 161
180    CONTINUE
C
C***** UPSTREAM CONVECTION CALCULATION
      VVP=(VIJ+VIPJ)*0.5
      VVM=(VIJ+VIMJ)*0.5
      UVP=(UIJ+UIMJ)*0.5
      UVM=(UIJM+UIMJM)*0.5
      VVIP=VTJ
      IF(VVP,LT, 0.0) VVIP=VIPJ
      VVIM=VIJ
      IF(VVM,GT, 0.0) VVIM=VIMJ
      VVIP=VTJ
      IF(UVP,LT, 0.0) VVIP=VIPJ
      VVIM=VIJ
      IF(UVM,GT, 0.0) VVIM=VIMJ
      DVVDY=(VVP+VVIP-VVM+VVIM)/DELY
      DUVDX=(UVP+VVIP-UVM+VVIM)/DELX
      IDIR=2
      CALL DIFFUS(NMAX,MMAX,I,J,DFLY,DELY,EPS,U,V,DVIP,IDIR)
C
182    CONTINUE
C
C***** ASSEMBLE HERE
C
      KOUNT=KP+1
      DIAGL(KOUNT)=COEFF3*MSEIMJ
      DIAG(KOUNT)=1.0
      DIAGU(KOUNT)=COEFF4*MSEIPJ
      ZETA=SEIJ-C2+(UIJ+MSEIPJ+UIJM+MSEIJM)
      RHS(KOUNT)=ZETA-RNDIIP
      IF(I,EQ, IFIRST .AND. .NOT. OPNLOW) GO TO 186
185    CONTINUE
      DIAGL(KP)=COEFF1
      DIAG(KP)=1.0
      DIAGU(KP)=COEFF2
      ZETA=AT+(-CORIY-RVIP+FYIP+DYIP-DVVDY-DUVDX)
      RHS(KP)=VIJ+ZETA-BNDLOW
      GO TO 187
186    CONTINUE
      DIAGL(KP)=0.0
      DIAGU(KP)=0.0
      DIAG(KP)=1.0
      RHS(KP)=0.0
187    CONTINUE
      KP=KOUNT+1
C
C***** CHECK FOR MORE CELLS
C
      IF(I,EQ, ILAST) GO TO 199
      I=I+1
      GO TO 159
199    CONTINUE

```

Listing 10 (continued)

```

      CALL TDIAG(DIAGL,DIAG,DIAGU,RHS,KOUNT)
C
      K2=1
      IL=ILAST
      DO 202 I=IFIRST,IL
      IM=I-1
      TEMP=DIAG(K2)
      IF(TEMP.GT. VBIG) TEMP=VBIG
      IF(TEMP.LT. -VBIG) TEMP=-VBIG
      VP(IM,J)=TEMP
      K2=K2+1
      TEMP=DIAG(K2)
      IF(TEMP.GT. SERIG) TEMP=SERIG
      IF(TEMP.LT. -SERIG) TEMP=-SERIG
      SEP(I,J)=TEMP
      K2=K2+1
202    CONTINUE
C
      NUM = NUM + 1
      GO TO 301
C
      COMPUTE UP ON ROW N ( SECOND HALF TIMESTEP
C
390    NUM = 1
      CALL ZERO(NMAX,MMAX,UP )
      CALL VBND(SEP,U,VP,NMAX,MMAX,NORD,NINDO,BNDV,TIDES,NUMTID,NOLA)
C
      IF(.NOT. TESTING) GO TO 320
C
C = EXTND
C
      CALL EXTND(NMAX,MMAX,MIDRY,SEP,U,VP)
C
C
320    CONTINUE
C
C = DRYCEL
C
      GOFIND=.FALSE.
      CALL DRYCEL(SEP,H,MIDRY,NMAX,MMAX,GOFIND)
C
340    IF(NUM.EQ.NIND) GO TO 402
      NSRCH =NBD(NUM)/1000000
      N      =NBD(NUM)/100000    * NSRCH*100
      MF      =NBD(NUM)/100 *NSRCH*10000 * N*100
      L      =NBD(NUM) * NSRCH*1000000 = N*10000 *MF*100
      NN = N = 1
      NNN = N + 1
      LL=L-1
      LLL=L+1
      MFF =MF-1
      J=N
      JFIRST=MF-1
      JLAST=L
      DO 460 J=JFIRST,JLAST
C
C = SETVAR
C
      CALL SETVAR(NMAX,MMAX,IJ,VP,SE,C,H,I,J)
C
      XSTRES=TAUX
C
      IF(J.EQ. JFIRST) GO TO 410
      IF(J.EQ. JLAST) GO TO 420
      GO TO 430

```

Listing 10 (continued)

```

C***** CELL CALCULATION
C
405  CONTINUE
      UUP=(UIJP+UIJ)*0.5
      UXJP=UIJ
      IF(UUP.LT. 0.0) UXJP=UIJP
      UUM=(UIJ + UTJM)*0.5
      UXJM=UIJ
      IF(UUM.GT. 0.0) UXJM=UIJM
      DUUDX=(UUP+UXJP-UUM+UXJM)/DELX
      VUP=(VIJ+VIJP)*0.5
      VUM=(VINJ+VIMJ)*0.5
      UYJP=UIJ
      IF(VUP.LT. 0.0) UYJP=UIPJ
      UYJM=UIJ
      IF(VUM.GT. 0.0) UYJM=UJMJ
      VI2J=(VIJ+VIJP+VIMJ+VIMJ)*0.25
      DUVDY=(VUP+UYJP-VUM+UYJM)/DELY

C
C***** HSEIJP MUST NOT BE CLOSE TO ZERO
      VSQ=(VI2J+VI2J)
      USQ=UIJ*UIJ
      VU=(VSQ+USQ)**0.5
      CSQ=((CIJP+CTJ)**2)/4.0
      FXJP=0.0
      RXJP=0.0
      IF(HSEIJP.LT. DEPTOL) GO TO 450

C
      VNDER=HSEIJP*CSQ*2.0
      VPTOP=AG*VU
      RXJP=VPTOP/VNDER

C
      FXJP=FXSTRES/HSEIJP
406  CONTINUE
C
      CORIX=F(J)*VI2J
C
C***** DIFFUSION TO BE ADDED AS DXJP
C
      IDIR=1
      CALL DIFFUS(NMAX,MMAX,I,J,DELX,DELY,EPS,U,VP,DXJP,IDIR)
      DSEDX=AG*(SETJP-SEIJ)/DELX
      RHSX=UIJ+AT*(DXJP+FXJP+CORIX-DUUDX-DUVDY=UIJ+RXJP-DSEDX)
      DENOM=1.0

C
C***** UP CALCULATION
C
      TEMP=RHSX/DENOM
      IF(TEMP.GT. UBIG) TEMP=UBIG
      IF(TEMP.LT. -UBIG) TEMP=-UBIG
      UP(I,J)=TEMP
      GO TO 450

C
410  CONTINUE
      XSTRES=0.0

C
C***** FIRST CELL. CHECK FOR OPEN BOUNDARY
C
      IF(NSRCH.LT. 10) GO TO 450
      CIJM=CIJ
      UIMJ=UIJ
      VIJ=0.0
      VIMJ=0.0
      GO TO 430
420  CONTINUE
      XSTRES=0.0

```

Listing 10 (continued)

```

C***** LAST CELL. CHECK FOR OPEN BOUNDARY
C
      IF(NSRCH,NE,1)AND(NSRCH,NE,11) GO TO 450
      CIJP=CIJ
      UIJP=UIJ
      VIJP=0.0
      VIMJP=0.0
      SEIJP=SEIJ
      GO TO 430
430    CONTINUE
C
C = SETBNX
C
      CALL SETBNX(NMAX,MMAX,I,J,MIDRY,V)
C
439    CONTINUE
      GO TO 405
450    CONTINUE
460    CONTINUE
      NUM = NUM + 1
      GO TO 340
402    CONTINUE
      CALL HBND(SEP,UP,VP,NMAX,MMAX,MORD,MINDO,BNDU,TIDES,NUMTID,MDLA)
      CALL DIVERG(UP,VP,NMAX,MMAX,DELY,DELY)
8001  FORMAT(/2X,*VP*)
8002  FORMAT(2X,*SEP*)
8003  FORMAT(2X,*UP*)
C
C = EDDY
C
8069  FORMAT(8(1X,E10.3,1X))
C
      DO 475 N=1,NMAX
      DO 475 M=1,MMAX
      IF(SEP(N,M).LT. SEMIN)SEMIN=SEP(N,M)
      IF(SEP(N,M).GT. SEMAX)SEMAX=SEP(N,M)
      IF(UP(N,M).LT. UMIN)UMIN=UP(N,M)
      IF(UP(N,M).GT. UMAX)UMAX=UP(N,M)
      IF(VP(N,M).LT. VMIN)VMIN=VP(N,M)
      IF(VP(N,M).GT. VMAX)VMAX=VP(N,M)
      ABSE=ABS(SEMAX)
      IF(ABSE.LT. 5.0*SCALET) GO TO 475
      GO TO 99A
475    CONTINUE
C
      CONST=1.0E-5
      CALL EDDY(NMAX,MMAX,EPS,U,V,DELY,DELY,CONST)
C
      IF(.NOT. TESTING) GO TO 470
C
C = FIND = CALL FIND IF ANY CELLS HAVE DRIED UP
C
      IF(.NOT. GOFIND) GO TO 470
C
C = FIND
C
      CALL FIND(MIND,NIND,MMAX,NMAX,MINDO,NINDO,NSECT,
      * NRD,MRD,M,MORD,NORD,SEP,MIDRY)
      CALL PUTOUT(NST,MMAX,NMAX,KONVRT,SE,SEP,V,VP,I,UP)
C
470    CONTINUE
C
      IF(PRTCLS) GO TO 529
480    CONTINUE

```

Listing 10 (continued)

```

      IF (TAPEOU) GO TO 490
487  CONTINUE
      KOUNT1=KOUNT1+1
      IF (NOUT .GT. KOUNT1) GO TO 488
      CALL PUTOUT(NST,MMAX,MHAX,KONVRT,SE,SEP,V
+ ,VP,U,UP)
      DO 4360 K=1,NTRAC
      I=TRACER(K,1)/DXT+2
      J=TRACER(K,2)/DYT+2
      WRITE(6,6021) K,I,J,(TRACER(K,II),II=1,3)
4360  CONTINUE
      KOUNT1=0
C
C = TRCOUT
C
      CALL TRCOUT(NTRAC,NMAX,MHAX,TRACER,MIABND,DXT,DYT,IJDUMP)
C
488  CONTINUE
      GO TO 605
490  CONTINUE
      KOUNT2=KOUNT2+1
      IF (KOUNT2 .LT. NOUT) GO TO 605
      KOUNT2=0
      THOUR=TYME/HOURD
      WRITE(6,6029) THOUR
      DO 600 K=1,NTRAC
      I=TRACER(K,1)/DXT+2
      J=TRACER(K,2)/DYT+2
      WRITE(6,6021) K,I,J,WZER(K),(TRACER(K,II),II=1,3)
600  CONTINUE
      I=IJDUMP/100
      J=IJDUMP-I*100
C
C = TRCOUT
C
      CALL TRCOUT(NTRAC,NMAX,MHAX,TRACER,MIABND,DXT,DYT,IJDUMP)
C
      WRITE(10) T(2),T(3),T(4),TYME,SEP,UP,VP,H,C,EPS
C
605  CONTINUE
      CALL SHIFT(NMAX,MHAX,U,V,SE,UP,VP,SEP)
      GO TO 88
500  CONTINUE
      ITRGO=2
C
C***** PARTICLE TRACING FROM PRECALCULATED DATA
C
505  CONTINUE
      WRITE(6,6089) SOURCE
      IF (NTRAC .LT. 1) GO TO 998
      WRITE(6,6006)
      DO 510 K=1,NTRAC
      READ(INFILE,5003) I,J,DIAM(K),ZLOC
      DIAM(K)=DIAM(K)*1.0E-06
      XLOC=DXT*(I-2)+DXT/2.0
      YLOC=DYT*(J-2)+DYT/2.0
      TRACER(K,1)=XLOC
      TRACER(K,2)=YLOC
      TRACER(K,3)=ZLOC
      WRITE(6,6005) K,I,J,DIAM(K),(TRACER(K,I),I=1,3)
510  CONTINUE
      GO TO (13,520,3341),ITRGO
520  CONTINUE

```

Listing 10 (continued)

```

      READ(9) T(2),T(3),T(4),TYME,SEP,UP,VP,H,C,EP8
      IF(EOF,9) 999,525
525  CONTINUE
      IF(FINISH .LT. 0.0) GO TO 529
      IF(BEGIN .GT. TYME) GO TO 520
      IF(FINISH .LT. TYME) GO TO 999
529  CONTINUE
C
C***** INTRODUCE ONE NEW TRACER EVERY HOUR AT DUMPING SITE
C
      TIMEIN=TIMEIN+DELT
      IF(TIMEIN .LT. HOURD) GO TO 535
      TIMEIN=0.0
      IF(NTRAC .GT. 199) GO TO 535
      NTRAC=NTRAC+1
      I=IJDUMP/100
      J=IJDUMP-I+100
      XLOC=DXT*(I-2)+DXT/2.0
      YLOC=DYT*(J-2)+DYT/2.0
      ZLOC=2.0
      TRACER(NTRAC,1)=XLOC
      TRACER(NTRAC,2)=YLOC
      TRACER(NTRAC,3)=ZLOC
      DIAM(NTRAC)=DIAM(1)
535  CONTINUE
C
C = TRACE
C
      CALL TRACE(CD,RHOW,NTRAC,DXT,DYT,TRACER,WZER,EP8,DELT,RHOP,DIAM
+ ,NMAX,MMAX,UP,VP,H,WZERP,SE,WAP,MIDRY)
C
C = CONZER
C
      CALL SCON(NMAX,MMAX,DXT,DYT,DELT,S,SP,VP,UP,EP8,MIDRY,IJDUMP
+ ,SOURCE,WPART)
      CALL PRTRAC(TYME,NTRAC,TRACER(1,1),TRACER(1,2),TRACER(1,3))
      WRITE(12) TYME,S
C
      GO TO(4A0,520),ITRGN
C
99A  CONTINUE
      WRITE(6,6022)
      GO TO 999
997  CONTINUE
      IF(.NOT. TAPEOU) GO TO 999
      ENDFILE 10
      ENDFILE 12
      ENDFILE 11
      WRITE(10) UMAX,UMIN,VMAX,VMIN,SEMAX,SEMIN
      WRITE(10) NTRAC,TRACER
      WRITE(6,6017)
      WRITE(6,6018) SEMAX,SEMIN,UMAX,UMIN,VMAX,VMIN
      REWIND 10
996  CONTINUE
      ISTEP=2
C
C = PUTOUT
C
      CALL PUTOUT(NST,MMAX,NMAX,KONVRT,SE,SEP,V,VP,U,IIP)
C
999  CONTINUE
      IF(.NOT. PRTELS) RETURN
C
C***** OUTPUT CONCENTRATIONS

```

Listing 10 (concluded)

```

CALL PNORM(S,NMAX,MMAX,NO)
C
C
5001 FORMAT(I10,2F10.0,20X)
5002 FORMAT(8(5X,15))
5003 FORMAT(2(10X,15),2(10X,F10.0))
5006 FORMAT(12A6)
5007 FORMAT(8(5X,F5.0))
5008 FORMAT(20I4)
C
C***** FORMATS
C
6000 FORMAT(1H1)
6001 FORMAT(1H ,I2,1X,32I4)
6002 FORMAT(* MAX, DELAY**,I3)
6003 FORMAT(* (MDLA(M),M=1,MM)*,15(1X,I3,2X))
6004 FORMAT(* (NDLA(MN,M=1,NM)*,15(1X,I3,2X))
6005 FORMAT(3(1X,I3,1X),4(1X,F10.3,1X))
6006 FORMAT(* TRACERS= SPECIALLY INPUT = NOT AT DUMPING SITE*)
6013 FORMAT(/2X,1HK,4X,7HWZER(K),21X,6HTRACER /)
6016 FORMAT(* TIME=,F10.1)
6017 FORMAT(///15X,5HSEMAX,5X,5HSEMIN,6X,4HVMAX,6X,4HUMIN,6X,4HVMAX
+ ,6X,4HVMIN)
6018 FORMAT(10X,6F10.3)
6019 FORMAT(* MORO = *,8I10)
6020 FORMAT(* NORD = *, 8I10)
6021 FORMAT(1X,I2,2(1X,I3,1X),4(1X,F10.3,2X))
6022 FORMAT(/* ERROR, NO PARTICLE DATA*/)
6023 FORMAT(/* PARTICLES/FT/FT */)
6024 FORMAT(1X,I2,11(1X,E9.2,1X)/3X,11(1X,E9.2,1X)/3X,11(1X,E9.2,1X))
6025 FORMAT(1X,8H RNDU ,10F10.4)
6026 FORMAT(1X,8H RNDV ,10F10.4)
6089 FORMAT(1H1,* SOURCE TERM=,E9.2/)
6031 FORMAT(16X,3(2X,E12.5,1X))
6030 FORMAT(1H1,22X,*UMIN*,11X,*UMAX*,11X,*VMIN*,11X,*VMAX*
+ ,9X,*SEMIN*,9X,*SEMAX*/)
6029 FORMAT(1H1,* TRACER POSITIONS AT TIME=,F6.2,* HOURS*/)
RETURN
END

```

Listing 11. SUBROUTINE ZERO

```

SUBROUTINE ZERO(NMAX,MMAX,ARYIN)
DIMENSION ARYIN(NMAX,MMAX)
C
DO 10 N=1,NMAX
DO 5 M=1,MMAX
ARYIN(N,M)=0.0
CONTINUE
5 CONTINUE
10 RETURN
END

```

Listing 12. SUBROUTINE DIFFUS

```

SUBROUTINE DIFFUS(NMAX,MMAX,I,J,DELX,DELY,EPS,U,V,DIFUSE,IOIR)
DIMENSION EPS(NMAX,MMAX),U(NMAX,MMAX),V(NMAX,MMAX)
C
  UIJP=U(I,J+1)
  UIJ=U(I,J)
  UIJM=U(I,J-1)
  UIPJ=U(I+1,J)
  UIMJ=U(I-1,J)
  VIJP=V(I+1,J)
  VIJ=V(I,J)
  VIJM=V(I,J-1)
  VIPJ=V(I+1,J)
  VIMJ=V(I-1,J)
  VIMJP=V(I-1,J+1)
  UIPJM=U(I+1,J-1)
C
  GO TO(100,200),IOIR
100 CONTINUE
C
  SXYP=EPS(I,J+1)*(UIJP=UIJ)/DELX
  SXXM=EPS(I,J)*(UIJ=UIJM)/DELX
  DESXX=(SXYP=SXXM)*2.0/DELX
C
  EIPJP=(EPS(I,J+1)+EPS(I,J)+EPS(I+1,J)+EPS(I+1,J+1))*0.25
  EIMJP=(EPS(I,J+1)+EPS(I,J)+EPS(I-1,J)+EPS(I-1,J+1))*0.25
C
  SXYP=(UIPJ=UIJ)/DELY+(VIJP=VIJ)/DELX)*EIPJP
  SXXM=(UIJ=UIMJ)/DELY+(VIMJP=VIMJ)/DELX)*EIMJP
  DESXY=(SXYP=SXXM)/DELY
C
  DXJP=DESXX+DESXY
  DIFUSE=DXJP
  GO TO 999
C
200 CONTINUE
  SYYP=EPS(I+1,J)*(VIPJ=VIJ)/DELY
  SYXM=EPS(I,J)*(VIJ=VIMJ)/DELY
  DESYY=(SYYP=SYXM)*2.0/DELY
C
  EIPJP=(EPS(I+1,J)+EPS(I,J)+EPS(I,J+1)+EPS(I+1,J+1))*0.25
  EIPJM=(EPS(I+1,J)+EPS(I,J)+EPS(I,J-1)+EPS(I+1,J-1))*0.25
C
  SXYP=(VIJP=VIJ)/DELY+(UIPJ=UIJ)/DELY)*EIPJP
  SXXM=(VIJ=VIMJ)/DELY+(UIPJ=UIJM)/DELY)*EIPJM
  DESXX=(SXYP=SXXM)/DELX
C
  DYIP=DESYY+DESXX
  DIFUSE=DYIP
999 CONTINUE
C
  RETURN
  END

```

Listing 13. SETVAR

```

SUBROUTINE SETVAR(NMAX,MMAX,U,V,SE,C,H,I,J)
  DIMENSION U(NMAX,MMAX),V(NMAX,MMAX),SE(NMAX,MMAX),C(NMAX,MMAX)
  + ,H(NMAX,MMAX)
C
  COMMON /PARAM/ UIJM,UIJP,UIJ,HIMJ,HIPJ,VIJ,VIJP,VIJM,VIMJ,VIPJ
  + ,VIMJM,VIMJP,UIMJM,UIPMJ,CIJ,CIJP,CIPJ,HIJ,HJJP,HIJM,HIPJ
  + ,HIMJ,HIMJP,HIMJM,HIPJM,HIPJP,HSEIPJ,HSEIMJ,HSEIJP,HSEIJM
  + ,XSTRES,YSTRES,SEIJ,SEIJM,SEIJP,SEIMJ,SEIPJ
  + ,CIMJ,CIJM
C
  UIJP=U(I,J+1)
  UIJ=U(I,J)
  UIPJ=U(I+1,J)
C
  SEIJ=SE(I,J)
  SEIJP=SE(I,J+1)
  SEIPJ=SE(I+1,J)
C
  VIJ=V(I,J)
  VIJP=V(I,J+1)
  VIPJ=V(I+1,J)
C
  CIJ=C(I,J)
  CIJP=C(I,J+1)
C
  HIJ=H(I,J)
  HJJP=H(I,J+1)
  HIPJ=H(I+1,J)
  HIPJM=H(I+1,J+1)
  IF(I.LE.1) GO TO 10
  CIMJ=C(I-1,J)
  UIMJ=U(I-1,J)
  SEIMJ=SE(I-1,J)
  VIMJ=V(I-1,J)
  VIMJP=V(I-1,J+1)
  HIMJ=H(I-1,J)
  HIMJP=H(I-1,J+1)
  GO TO 12
10
  CONTINUE
  CIMJ=CIJ
  UIMJ=UIJ
  SEIMJ=SEIJ
  VIMJ=VIJ
  VIMJP=VIJP
  HIMJ=HIJ
  HIMJP=HIJP
12
  CONTINUE
  IF(J.LE.1) GO TO 20
  CIJM=C(I,J-1)
  UIJM=U(I,J-1)
  SEIJM=SE(I,J-1)
  VIJM=V(I,J-1)
  UIPJM=U(I+1,J-1)
  HIJM=H(I,J-1)
  HIPJM=H(I+1,J-1)
  GO TO 22
20
  CONTINUE
  CIJM=CIJ
  UIJM=UIJ
  SEIJM=SEIJ
  VIJM=VIJ
  UIPJM=UIPJM
  HIJM=HIJ
  HIPJM=HIPJM

```

Listing 13 (concluded)

```

22      CONTINUE
      IF(I .LE. 1 .AND. J .LE. 1) GO TO 30
      IF(I .LE. 1 .AND. J .GT. 1) GO TO 40
      IF(J .LE. 1 .AND. I .GT. 1) GO TO 50
      VIMJM=V(I=1,J=1)
      UIMJM=U(I=1,J=1)
      HIMJM=H(I=1,J=1)
      GO TO 70
30      CONTINUE
      VIMJM=VIJ
      UIMJM=UIJ
      HIMJM=HIJ
      GO TO 70
40      CONTINUE
      VIMJM=VIJM
      UIMJM=UIJM
      HIMJM=HIJM
      GO TO 70
50      CONTINUE
      VIMJM=VIMJ
      UIMJM=UIMJ
      HIMJM=HIMJ
70      CONTINUE
      HSEIPJ=(HIJ+HIJM+SEIPJ+SEIJ)*0.5
      HSEIMJ=(HIMJ+HIMJM+SEIJ+SEIMJ)*0.5
      HSEIJP=(HIJ+HIMJ+SEIJ+SEIJP)*0.5
      HSEIJM=(HIJM+HIMJM+SEIJ+SEIJM)*0.5
      CIPJ=C(I+1,J)
      RETURN
      END

```

Listing 14. SUBROUTINE EDDY

```

SUBROUTINE EDDY(IMAX,JMAX,EPS,U,V,DELX,DELY,CONST)
  DIMENSION EPS(IMAX,JMAX), U(IMAX,JMAX), V(IMAX,JMAX)
  IMAXM=IMAX-1
  JMAXM=JMAX-1
  SCALE=.001
  DO 40 J=2,JMAXM
    DO 20 I=2,IMAXM
      DUDX=(U(I,J) + U(I,J+1) + U(I,J-1) + U(I+1,J+1)) / 4.0 /DELX
      DUDY=(U(I,J) - U(I,J+1)) / DELY
      DVDY=(V(I,J) + V(I+1,J) - V(I-1,J) + V(I-1,J+1)) / 4.0 /DELY
      DVDX=(V(I,J) - V(I-1,J)) / DELX
      SXX=2.0 * DVDX
      SXY=DUDX + DVDY
      SYX=SXY
      SYY=2.0 * DUDY
      SMNSMN=SXX*SXX + SXY*SXY + SYX*SYX + SYY*SYY
      IF(SMNSMN.LT. 1.0E-20) SMNSMN= 1.0E-20
      EPS(I,J)=SCALE*DELX*DELY*SQRT(SMNSMN)*CONST
20      CONTINUE
40      CONTINUE
      RETURN
      END

```

Listing 15. SUBROUTINE TRACE

```

SUBROUTINE TRACE(CD,RHOW,NTRAC,DELY,DELY,TRACER,WZER,EPS,DELT
+ ,RHOP,DIAM,NMAX,MMAX,U,V,M,WZERP,SE,WAP,MIDRY)
C
  DIMENSION H(NMAX,MMAX),U(NMAX,MMAX),V(NMAX,MMAX),EPS(NMAX,MMAX)
+ ,TRACER(200,3),WZER(NTRAC),WZERP(NTRAC),DIAM(NTRAC)
+ ,SE(NMAX,MMAX),WAP(NMAX,MMAX)
+ ,MIDRY(NMAX,MMAX)
C
  HORIZX=DELY*(NMAX-1)
  HORIZY=DELY*(MMAX-1)
  IF(NTRAC.LT. 1) RETURN
  G=9.81
  WTERM = -2.0E-05
  CORH0W=CD+RHOW
  COEF=0.75+CORH0W
  DO 1000 K=1,NTRAC
    WAPN = 0.0
    XLOC=TRACER(K,1)/DELY
    YLOC=TRACER(K,2)/DELY
    ZLOC=TRACER(K,3)
    ZP=ZLOC
    N=XLOC+2
    M=YLOC+2
    IF(MIDRY(N,M).GT. 1) GO TO 999
    HP= (H(N,M)+H(N-1,M)+H(N,M-1)+H(N-1,M-1))*0.25
    HSE=HP + SE(N,M)
    IF(HSE.LT. 0.1) GO TO 10
    WAPN=EPS(N,M)/HSE
  10 CONTINUE
C
C   NOW MOVE TRACERS
C
  CALL UVINT(U,V,NMAX,MMAX,DELY,DELY,TRACER(K,1),TRACER(K,2)
+ ,UPI,VPI)
C
  XN=N-2
  YN=M-2
  DX=TRACER(K,1)-XN*DELY=DELY*0.5
  DY=TRACER(K,2)-YN*DELY=DELY*0.5
C
C   FIND FX(Z) AND FY(Z)
C
  ALPHAX=0.75
  ALPHAY=0.75
  HP= (H(N,M)+H(N-1,M-1)+H(N-1,M)+H(N,M-1))*0.25
C
  FXZ=1.0
  FYZ=1.0
  UPZ=UPI*FXZ
  VPZ=VPI*FYZ
C
  XLOC=TRACER(K,1)
  YLOC=TRACER(K,2)
  XLOC=XLOC+DELT*VPZ
  YLOC=YLOC+DELT*UPZ
  IF(XLOC.LT. 0.0) XLOC=0.0
  IF(XLOC.GT. HORIZX) XLOC=HORIZX
  IF(YLOC.LT. 0.0) YLOC=0.0
  IF(YLOC.GT. HORIZY) YLOC=HORIZY
  ZLOC=ZLOC+DELT*(2.0+WTERM+WAP(N,M)+WAPN)*0.5
  IF(ZLOC.GT. -HP .AND. ZLOC.LT. SE(N,M)) GO TO 999
  ZLOC=HP

```

Listing 15 (concluded)

```

995      CONTINUE
        IF(ZLOC .LT. HSE) GO TO 996
        ZLOC=HSE
996      CONTINUE
        TRACER(K,1)=XLOC
        TRACER(K,2)=YLOC
        TRACER(K,3)=ZLOC
999      CONTINUE
1000     CONTINUE
        DO 1015 N=2,NMAX
          WAP(N,M) = 0.0
          HP=(H(N,M)+H(N+1,M)+H(N,M+1)+H(N+1,M+1))*0.25
          HSE=HP+SE(N,M)
          IF(HSE .LT. 0.10) GO TO 1014
          WAP(N,M)=EPS(N,M)/HSE
1014     CONTINUE
1015     CONTINUE
1020     CONTINUE
        RETURN
        END

```

Listing 16. SUBROUTINE TDIAG

```

SUBROUTINE TDIAG(DIAGL,DIAG,DIAGU,RHS,NPT)
  DIMENSION DIAGL(NPT),DIAG(NPT),DIAGU(NPT),RHS(NPT)
  DIAGU(1)=DIAGU(1)/DIAG(1)
  RHS(1)=RHS(1)/DIAG(1)
  IF(NPT .LT. 2) GO TO 30
  DO 10 I=2,NPT
    Z1=DIAG(I)-DIAGL(I)*DIAGU(I-1)
    Z2=RHS(I)-RHS(I-1)*DIAGL(I)
    RHS(I)=Z2/Z1
    Z3=DIAGU(I)
    DIAGU(I)=Z3/Z1
  10   CONTINUE
C
C====NOW BACK SUBSTITUTION====
C
  DIAG(NPT)=RHS(NPT)
  DO 20 I=2,NPT
    I=NPT+1-I
    DIAG(I)=RHS(I)-DIAGU(I)*DIAG(I+1)
  20   CONTINUE
  RETURN
  30   CONTINUE
  DIAG(1) = RHS(1)/DIAG(1)
  RETURN
  END

```

Listing 17. SUBROUTINE TIDE

```

SUBROUTINE TIDE(DELTA, LONG, WATLEV, PHI)
COMMON /TIDES/ DECL, ANG, ANGM, ANGE, RAD, OMEGA, OMEGA, OMEGA,
1 DISTH, DISTV
C
C***** DECL = DECLINATION OF EARTH = 23.5 DEG
C ANG = ANGLE BETWEEN EARTH-SUN = XAXIS
C ANGM = ANGLE BETWEEN EARTH-MOON = XAXIS
C ANGE = ANGLE BETWEEN STATION-EARTH = XAXIS
C LAT = LATITUDE OF STATION
C RAD = 180.0/PI
C
C DELT IS IN HOURS
C
REAL LONG, LAMDA, LAMDA
DISTH=3963.0
RAD=180.0/3.141592654
SINP=SIN(PHI)
SIND=SIN(DECL)
P2=2.0*PHI
D2=2.0*DECL
SINP2=SIN(P2)
SIND2=SIN(D2)
COSP=COS(PHI)
COSD=COS(DECL)
ANG=ANG+OMEGA*DELTA
ANGM=ANGM+OMEGA*DELTA
ANGE=ANGE+OMEGA*DELTA
ANE=ANGE+LONG
LAMDA=3.141592654+ANE+ANG
LAMDA=ANE+ANGM
COSLM=COS(LAMDA)
COSLS=COS(LAMDA)
C
CON1=3.0*SINP*SINP*SIND*SIND-1.0
CON2=1.5*SINP2*SIND2
CON3=COSP*COSP*COSD*COSD
CON4=1981.5*5280.0*(7926.0/DISTH)**3/81.5
CON5=1981.5*5280.0*(7926.0/DISTV)**3*3.28*1.0E+05
TIDH=CON4*(CON1+CON2+COSLM*CON3+COSLM+COSLM)
TIDS=CON5*(CON1+CON2+COSLS*CON3+COSLS+COSLS)
AE=ANE+RAD
AM=ANGM+RAD
AS=ANG+RAD
6000 FORMAT(/* TIDH=*,E12.5,* TIDS=*,E12.5)
6001 FORMAT(* ANGE=*,E12.5,* ANGM=*,E12.5,* ANG=*,E12.5)
WATLEV=(TIDH+TIDS)*0.67
RETURN
END

```

Listing 18. SUBROUTINE RESET

```

SUBROUTINE RESET
REAL LONG
COMMON /TIDES/ DECL,ANGS,ANGM,ANGE,RADS,OMEGAE,OMEGAM,OMEGAS,
1  DISTM,DISTS
COMMON /FIRSTD/ YEAR1,DAY1,HOURL,ANGLES,ANGLEM,ANGLEE
RADS=180.0/3.141592654
YEAR1=1958.0
ANGLES=(324.0+47.0/60.0+35995/3600.0)/RADS
ANGLEM=144.68139/RADS
ANGLEE=0.0
ANGLES=REDANG(ANGLES)
ANGLEM=REDANG(ANGLEM)
DAY1=45.0
HOURL=0.0
RETURN
END

```

Listing 19. SUBROUTINE DRYCEL

```

SUBROUTINE DRYCEL(SE,H,MIDRY,NMAX,MMAX,GOSET)
DIMENSION SE(NMAX,MMAX),H(NMAX,MMAX),MIDRY(NMAX,MMAX)
C
LOGICAL GOSET
GOSET=.FALSE.
DRYUP=0.10
C
DO 20 J = 2,MMAX
DO 10 I = 2,NMAX
ISAVE=MIDRY(I,J)
MIDRY(I,J)=1
MIJ=(H(I,J)+H(I,J=1)+H(I=1,J)+H(I=1,J=1))*0.5+SE(I,J)
IF(MIJ.LT. DRYUP) MIDRY(I,J)=2
IF(MIDRY(I,J).NE. ISAVE) GOSET=.TRUE.
10 CONTINUE
20 CONTINUE
C
DO 40 J=1,MMAX
MIDRY(1,J)=MIDRY(2,J)
MIDRY(NMAX,J)=MIDRY(NMAX-1,J)
40 CONTINUE
C
DO 50 I=1,NMAX
MIDRY(I,1)=MIDRY(I,2)
MIDRY(I,MMAX)=MIDRY(I,MMAX-1)
50 CONTINUE
C***** FORMATS FOR DRYCEL
C
6000 FORMAT(5X,I5,3I12)
6001 FORMAT(1H1,10X,12HMIDRY VALUES /)
RETURN
END

```

Listing 20. SUBROUTINE DIVERG

```

SUBROUTINE DIVERG(IJ,V,NMAX,MMAX,DELX,DELY)
  DIMENSION U(NMAX,MMAX), V(NMAX,MMAX), DIV( 10,12)
  DO 20 N=2,9
    DO 10 M=2,6
      DUDX=(U(N,M) - U(N,M-1))/DELX
      DVDY=(V(N,M) - V(N-1,M))/DELY
      DIV(N,M)=DUDX+DVDY
10    CONTINUE
20  CONTINUE
1000 FORMAT(8(1X,E15.5,1X))
1001 FORMAT(//2X,*DIVERG VALUES*)
  RETURN
END

```

Listing 21. SUBROUTINE REDANG

```

FUNCTION REDANG(ANGLE)
  PI=3.141592654
  TWOPI=2.0*PI
C ***** ANGLE IS IN RADIANS. 2.0*PI*RADS = 1 REVOLUTION = 360.0 DEGREES
C
  RADS=57.2957795
  REVS=ANGLE/TWOPI
  IREV=REVS
  XREVS=IREV
  REDANG=ANGLE-TWOPI*XREVS
  RETURN
END

```

Listing 22. SUBROUTINE SHIFT

```

SUBROUTINE SHIFT(NMAX,MMAX,U,V,SE,UP,VP,SEP)
  DIMENSION U(NMAX,MMAX), V(NMAX,MMAX), SE(NMAX,MMAX)
  * , SEP(NMAX,MMAX), UP(NMAX,MMAX), VP(NMAX,MMAX)
  DO 10 I=1,NMAX
    DO 5 J=1,MMAX
      U(I,J)=UP(I,J)
      V(I,J)=VP(I,J)
      SE(I,J)=SEP(I,J)
5    CONTINUE
10  CONTINUE
C
  RETURN
END

```

Listing 23. SUBROUTINE UVINT

```

SUBROUTINE UVINT(U,V,IMAX,JMAX,DELX,DELY,XLOC,YLOC,UP,VP)
  DIMENSION U(IMAX,JMAX), V(IMAX,IMAX)
  IU=XLOC/DELX
  JU=(YLOC-DELY*0.5)/DELY
  DXU=XLOC-DELX*(IU-DELX*0.5)
  DYU=YLOC-DELY*(JU+1)
  ABDXU=ABS(DXU)
  ABDYU=ABS(DYU)
  AU1=(DELX-ABDXU)*(DELY-ABDYU)
  AU2=(DELX-ABDXU)*ABDYU
  AU3=(DELY-ABDYU)*ABDXU
  AU4=ABDYU*ABDXU
  IX=IU+2
  JX=JU+2
  IPX=IX+1
  IF(DXU .LT. 0.0) IPX=IX-1
  JPY=JX+1
  IF(DYU .LT. 0.0) JPY=JX-1
  AU=AU1+AU2+AU3+AU4
  U1=U(IX,JX)
  U2=U(IPX,JX)
  U3=U(IPX,JX)
  U4=U(IPX,JPY)
  UP=(U1*AU1+U2*AU2+U3*AU3+U4*AU4) / AU
C
C***** NOW VP
C
  IV=(XLOC-DELX*0.5)/DELX
  JV=YLOC / DELY
  DXV=XLOC-DELX*(IV+1)
  DYV=YLOC -DELY*JV - DELY*0.5
  ABDXV=ABS(DXV)
  ABDYV=ABS(DYV)
  AV1=(DELX - ABDXV)*(DELY - ABDYV)
  AV2=(DELX - ABDXV)*ABDYV
  AV3=(DELX - ABDXV)*ABDYV
  AV4=ABDXV*ABDYV
  AV=AV1+AV2+AV3+AV4
  IV=IV+2
  JV=JV+2
  IPY=IV+1
  IF(DXV .LT. 0.0) IPY=IV-1
  JPY=JV+1
  IF(DYV .LT. 0.0) JPY=JV-1
  V1=V(IV,JY)
  V2=V(IPY,JY)
  V3=V(IPY,JPY)
  V4=V(IPY,JPY)
  VP=(V1*AV1 + V2*AV2 + V3*AV3 + V4*AV4) / AV
  RETURN
  END

```

Listing 24. SUBROUTINE SCON

```

SUBROUTINE SCON(NMAX,MMAX,DELY,DELY,DELT,S,SP,V,U,EPS,MIDRY
+ ,IJCUMP,SOURCE,WPART)
C
C***** CONCENTRATION (S) SIMULATION
C
C      DIMENSION S(NMAX,MMAX),SP(NMAX,MMAX),EPS(NMAX,MMAX),V(NMAX,MMAX)
+ ,MIDRY(NMAX,MMAX),U(NMAX,MMAX)
C      INTEGER SOUTH,EAST,WEST
C      LOGICAL START
C
C***** DIRECTION DEFINITION
C
C      S
C      I
C      I
C      E - - - + - - - W = (I+1)
C      I
C      I
C      COMPUTATIONAL NORTH
C      (J+1)
C
C      NMAX=MMAX=1
C      I=1
10  CONTINUE
C      I=I+1
C      IF(I.GT. NMAX) GO TO 90
C      J=1
C      START=.FALSE.
20  CONTINUE
C      J=J+1
C      IF(J.GT. MMAX) GO TO 10
C      IR=MIDRY(I,J)
C      IF(START) GO TO 30
C      IF(IR.GT. 1) GO TO 20
C      START=.TRUE.
30  CONTINUE
C      IF(IR.GT. 1) GO TO 80
C
C      SIJ=S(I,J)
C      SIPJ=S(I+1,J)
C      SIMJ=S(I-1,J)
C      SIJP=S(I,J+1)
C      SIJM=S(I,J-1)
C
C      EIJ=EPS(I,J)
C      EIPJ=EPS(I+1,J)
C      EIMJ=EPS(I-1,J)
C      EIJP=EPS(I,J+1)
C      EIJM=EPS(I,J-1)
C
C      UIJ=U(I,J)
C      UIJM=U(I,J-1)
C      VIJ=V(I,J)
C      VIJM=V(I-1,J)
C
C      NORTH=MIDRY(I,J+1)

```

Listing 24 (concluded)

```

WEST=MIDRY(I+1,J)
SOUTH=MIDRY(I,J-1)
EAST=MIDRY(I-1,J)
C
      IF(NORTH .LT. 2) GO TO 40
      SIJP=2.0*SIJ-SIJM
      EIJP=2.0*EIJ-FIJM
40      CONTINUE
      IF(SOUTH .LT. 2) GO TO 50
      SIJM=2.0*SIJ-SIJP
      EIJM=2.0*EIJ-FIJP
50      CONTINUE
      IF(EAST .LT. 2) GO TO 60
      SIMJ=2.0*SIJ-SIPJ
      EIMJ=2.0*EIJ-EIPJ
60      CONTINUE
      IF(WEST .LT. 2) GO TO 70
      SIPJ=2.0*SIJ-SIMJ
      EIPJ=2.0*EIJ-EIMJ
70      CONTINUE
C
C***** CELL CALCULATION DONE HERE
C
      USP=UIJ*SIJ
      IF(UIJ .LT. 0.0) USP=UIJ*SIJP
      USM=UIJM*SIJ
      IF(UIJM .GT. 0.0) USM=UIJM*SIJM
      VSP=VIJ*SIJ
      IF(VIJ .LT. 0.0) VSP=VIJ*SIPJ
      VSM=VIMJ*SIJ
      IF(VIMJ .GT. 0.0) VSM=VIMJ*SIMJ
      DUSDY=(USP-USM)/DELX
      DVSDY=(VSP-VSM)/DELY
      EIJ=0.5*EIJ + 0.125*(EIJP+FIJM+EIMJ+EIPJ)
      D2SDX=EIJ*(SIJP=2.0*SIJ+SIJM)/DELX/DELX
      D2SDY=EIJ*(SIPJ=2.0*SIJ+SIMJ)/DELY/DELY
      DSDX=(SIJP-SIJM)/2.0/DELX
      DSDY=(SIPJ-SIMJ)/2.0/DELY
      DEDX=(EIJP-EIJM)/2.0/DELX
      DEDY=(EIPJ-EIMJ)/2.0/DELY
      SUSPEN=(DEDX*WPART)*DSDX+(DEDY*WPART)*DSDY
      IF(SUSPEN .LT. 0.0) SUSPEN=0.0
      ETAIJ= D2SDX + D2SDY + (DUSDX + DVSDY)
      IJ=I+100+J
      IF(IJ .EQ. IJDUMP) ETAIJ=ETAIJ+SOURCE
      SP(I,J)=S(I,J)+DELT*(ETAIJ+SUSPEN)
      GO TO 20
80      CONTINUE
      START=.FALSE.
      GO TO 20
90      CONTINUE
C
C***** INTERCHANGE SP AND S
C
      DO 110 J = 1,NMAX
      DO 100 I = 1,NMAX
      S(I,J)=SP(I,J)
100      CONTINUE
110      CONTINUE
      RETURN
      END

```

Listing 25. SUBROUTINE PUTOUT

```

SUBROUTINE PUTOUT(NST,MMAX,NMAX,KONVRT,SE,SEP,V
+ ,VP,U,UP)
  DIMENSION KONVRT(NMAX),SE(NMAX,MMAX),SEP(NMAX,MMAX)
+ , V(NMAX,MMAX), VP(NMAX,MMAX), U(NMAX,MMAX), UP(NMAX,MMAX)

C
C
C      PRINT INSTRUCTIONS
C
  NS=NST
  NST=NST-1
  WRITE(6,5020) NST
  DO 6000 M=1,MMAX
  DO 6006 N=1,NMAX
6006 KONVRT(N)=(SE(N,M)+SEP(N,M))*50.
6000 WRITE(6,6001) M,(KONVRT(N),N=1,NMAX)
  WRITE(6,5021) NST
  DO 6003 M=1,MMAX
  DO 6007 N=1,NMAX
6007 KONVRT(N)=(V(N,M)+VP(N,M))*50.
6003 WRITE(6,6001) M,(KONVRT(N),N=1,NMAX)
  WRITE(6,5022) NST
  DO 6004 M=1,MMAX
  DO 6008 N=1,NMAX
6008 KONVRT(N)=(U(N,M)+UP(N,M))*50.
6004 WRITE(6,6001) M,(KONVRT(N),N=1,NMAX)
  NST=NS
297 RETURN
5020 FORMAT(1H1,* CALCULATED WATER SURFACE= METERS*,1H*,*100.*
+ /* AFTER*,15,* TIME STEPS*/)
5021 FORMAT(1H1,* CALCULATED V-VELOCITIES=(METERS/SEC)*,1H*,*100.*
+ /* AFTER*,15,* TIME STEPS*/)
5022 FORMAT(1H1,* CALCULATED U-VELOCITIES=(METERS/SEC)*,1H*,*100.*
+ /* AFTER*,15,* TIME STEPS*/)
6001 FORMAT(2X,32I4)
  END

```

Listing 26. SUBROUTINE PRTRAC

```

SUBROUTINE PRTRAC(TYME,NTRAC,TRACX,TRACY,TRACZ)
  DIMENSION TRACX(NTRAC),TRACY(NTRAC),TRACZ(NTRAC)
  WRITE(11) TYME,NTRAC
  WRITE(11) TRACX,TRACY,TRACZ
  RETURN
  END

```

Listing 27. SUBROUTINE DATARD

```

SUBROUTINE DATARD
  COMMON / P19 / R(19)
  COMMON / I4 / I(4)
  READ(9) R,I
  RETURN
  END

```

Listing 28. SUBROUTINE DEPTH

```

SUBROUTINE DEPTH(NMAX,MMAX,H,MSL,METER,DEPMAX,INFILE)
  DIMENSION H(NMAX,MMAX),DEPIN(15)
  REAL MSL
  INTEGER ROW, CARD
  LOGICAL METER
  DO 2 M = 1,MMAX
    DO 1 N = 1, NMAX
      H(N,M) = 30.0
    CONTINUE
  CONTINUE
  C
  C***** INPUT IN FEET OR METERS
  C      • DEPTH INPUT IS LLW
  C      • MSL IS HEIGHT ABOVE LLW OF MEAN SEA LEVEL
  C      • PROGRAM CONVERTS TO METERS
  C      • EACH ROW MUST END WITH 99.9
  C
  MMAX=M*MMAX-1
  KOUNT1=0
  DO 10 M = 1, MMAX
    N = 0
    KOUNT2=1
    CONTINUE
  4   READ(INFILE,5000) ROW,CARD,(DEPIN(I),I=1,15)
      IF( M .NE. ROW) GO TO 98
      KOUNT1=KOUNT1+1
      IF(KOUNT2 .NE. CARD) GO TO 98
      KOUNT2=KOUNT2+1
      DO 5 I = 1, 15
        IF(DEPIN(I) .LE. -99.9) GO TO 6
        N = N + 1
        IF(.NOT. METER) DEPIN(I)=DEPIN(I)*.3048
        IF(DEPIN(I) .LT. 0.0) DEPIN(I)=-89.9
        H(N+1,ROW+1)=MSL+DEPIN(I)
      CONTINUE
  5   GO TO 4
  6   CONTINUE
  10  CONTINUE
      GO TO 99
  98  CONTINUE
      WRITE(6,6000)
      WRITE(6,6001) KOUNT1,ROW,CARD,(DEPIN(I),I=1,15)
      CALL EXIT
  99  CONTINUE
  C
  C----- SITE DEPENDENT CODE
  C
      DO 555 M = 1,MMAX
        H(1,M)=90.0
        H(31,M)=H(30,M)
      555 CONTINUE
      DO 556 N = 1,NMAX
        H(N,1)=H(N,2)
      556 CONTINUE
      DEPMAX=0.0
      DO 690 N=1,NMAX
        DO 600 M=1,MMAX
          IF(H(N,M) .GT. DEPMAX) DEPMAX=H(N,M)
        CONTINUE
      690 CONTINUE
      RETURN
  5000 FORMAT(2I2,1X,15F5.0)
  6000 FORMAT(/"-----ERROR--- DEPTH CARDS---"/" EXECUTION TERMINATING"/)
  6001 FORMAT(" DEPTH CARD NUMBER ",I4," IS AS FOLLOWS")
  + 1X,2I2,1X,15F5.0/1H1)
  END

```

Listing 29. SUBROUTINE PRNT

```

SUBROUTINE PRNT(NMAX,MMAX,NCARD,MINDO,NINDO,NSECT,NSTAT,NTRAC
+ ,LEN,LEN2,NI,INLET,IJDUMP,MOBD
+ ,NORD,TITL,H,NH,C,MAXST,BNDU,BNDV)
C
C
COMMON /R19 / LATUDE, LONGIT, RHOW, RHOP, WINDX, WINDY, YEAR, DAY, HOUR
+ ,HHW, DATUM, SEIN, G, DELX, DELY, DELT, HORIZX, HORIZY, DEPMAX
COMMON /DATA1 / NMAXM, MMAXM, CONZER, ITRGO, AG, PI, RADS, WINDCO, UMIN
+ ,UMAX, VMIN, VMAX, SFMIN, SEMAX, NM, MM
DIMENSION MOBD(MINDO), NORD(NINDO), TITL(12), H(NMAX, MMAX), NH(NMAX)
+ , C(NMAX, MMAX), BNDU(MINDO), BNDV(NINDO)
REAL LONGIT, LATUDE
C
C**** WRITE INITIAL VALUES
WRITE(6,6016) (TITL(J),J=1,12)
WRITE(6,6002) NMAX,MMAX,DELX,DELY,HORIZX,HORIZY,DEPMAX
+ ,HHW,DATUM,DELT,WINDX,WINDY,LATUDE, LONGIT
+ ,DAY, YEAR, NI, MAXST
ID=IJDUMP/100
JD=IJDUMP-ID*100
WRITE(6,6003) NTRAC, ID, JD
WRITE(6,6008) (MOBD(M),M=1,MM)
WRITE(6,6025) (BNDU(M),M=1,MM)
WRITE(6,6010) (NORD(N),N=1,NH)
WRITE(6,6026) (BNDV(N),N=1,NH)
WRITE(6,6012) (TITL(J),J=1,12)
WRITE(6,6009)
DO 9 M=1, MMAX
DO 40 N=1, NMAX
40 NH(N)=H(N,M)*10. +.01
9 WRITE(6,6001) M, (NH(N),N=1,NMAX)
C
6001 FORMAT(1H ,12,1X,32I4)
6002 FORMAT(* SITE PARAMETERS*// * NUMBER OF CELLS IN X (NMAX)=*,I3/
+ 20X,*Y (MMAX)=*,I3// * X-GRID SPACING (DELX)=*,F8,2/
+ * Y*,14X,* (DELY)=*,F8,2// * MAXIMUM X-DISTANCE=*,F10,4/
+ 9X,*Y*,9X,**,F10,4/14X,*DEPTH=*,F8,4// * HIGH WATER IS=*,F4,1/
+ * MEAN SEA LEVEL IS=*,F4,2,* METERS ABOVE LOWER LOW WATER*//
+ * TIME STEP =*,F8,2// * X-WIND COMPONENT (WINDX)=*,F8,4/
+ * Y*,16X,* (WINDY)=*,F8,4// * LATITUDE, LONGITUDE=*,2(2X,F8,2)//
+ * DAY AND YEAR ARE *,F4,0,*,*,F5,0//
+ * NUMBER OF SEAWARD OPENINGS=*,I2/
+ * MAXIMUM NUMBER OF STEPS=*,I4)
6003 FORMAT(* NUMBER OF TRACERS SPECIFIED =*,I4/
+ * DUMPING SITE IS AT 1*,12,*, J*,12/)
6016 FORMAT(1H1,* DREDGE MATERIAL DISPERSION SIMULATION MODEL*/
+ * DR. L. D. SPRAGGS-- HYDROSTM INC.*//
+ * SIMULATION OF *,12A6/)
6004 FORMAT(8X,5HMAXST,6X,2HNI,5X,4HLATUDE,4X,6HLONGIT,5X,4HDELX,6X
+ ,4HDELY,6X,4HDELT,5X,5HWINDX,5X,5HWINDY)
6005 FORMAT(1X,2I10,7F10,2//)
6006 FORMAT(7X,4HYEAR,6X,3HDAY,7X,4HHOUR,5X,6HHORIZX,4X,6HHORIZY,4X
+ ,6HDEPMAX,5X,3HHW,6X,5HSEIN,5X,5HDATUM,7X,5HINLET,4X,6HIJDUMP)
6007 FORMAT(1X,9F10,2,2I10//)
6008 FORMAT(1X,8H NORD ,10I10)
6009 FORMAT(1X,29HINITIAL DEPTHS IN .1 )
6010 FORMAT(///1X,8H NORD ,10I10)
6011 FORMAT(1X,28HC VALUES UNTIL NEXT PRINTOUT)
6012 FORMAT(1H1,12A6)
6015 FORMAT(1H ,12,1X,32F4,0)
6025 FORMAT(1X,8H BNDU ,10F10,0)
6026 FORMAT(1X,8H BNDV ,10F10,0)
RETURN
END

```

Listing 30. SUBROUTINE TAPDAT

```

SUBROUTINE TAPDAT(NMAX,MMAX,TYME,RSTART,SE,U,V,H,C,EPS,NSTP)
  DIMENSION SE(NMAX,MMAX),U(NMAX,MMAX),V(NMAX,MMAX),H(NMAX,MMAX)
  * ,C(NMAX,MMAX),EPS(NMAX,MMAX)
  COMMON / TIDES / T(10)
C
C***** INPUT FROM TAPE9
C
  IF(RSTART .LT. 0.0) RSTART=1.0E+30
10  CONTINUE
  READ(9) T(2),T(3),T(4),TYME,SE,U,V,H,C,EPS
  IF(EOF,9)99,20
20  CONTINUE
  IF(TYME .LT. RSTART)GO TO 10
C
C***** FIND EOF ON TAPE AND PREPARE FOR TRACER DATA
C
25  CONTINUE
  READ(9) T(10)
  IF(EOF,9) 99,25
99  CONTINUE
  RETURN
  END

```

Listing 31. SUBROUTINE PRNTR

```

SUBROUTINE PRNTR(FINISH,REGIN,TYME,NST,MMAX,NMAX
  * ,KONVRT,SEP,VP,UP,H,C,EPS)
  DIMENSION SEP(NMAX,MMAX),UP(NMAX,MMAX),VP(NMAX,MMAX),H(NMAX,MMAX)
  * ,C(NMAX,MMAX),EPS(NMAX,MMAX),VPRINT(80),KONVRT(NMAX)
  COMMON /TIDES / T(10)
  ISTEP=2
  NST=0
  IP=0
  IF(REGIN .GT. TYME) GO TO 50
20  CONTINUE
  WRITE(6,6000) TYME
  CALL PUTOUT(NST,MMAX,NMAX,KONVRT,SEP,SEP
  * ,VP,VP,UP,UP)
  NST=NST+1
  READ(9) T(2),T(3),T(4),TYME,SEP,UP,VP,H,C,EPS
  IF(EOF,9) 100,45
45  CONTINUE
  IF(TYME .LE. FINISH) GO TO 20
  GO TO 100
50  CONTINUE
  WRITE(6,6001) REGIN, TYME
100 CONTINUE
  CALL EXIT
C
6000 FORMAT(//* SIMULATION AT *,F10.0)
6001 FORMAT(//* BEGINNING TIME OF *,F10.0,* ,GT. LAST TIME OF *,F10.0
  * ,* ON TAPE9 *)
  END

```

Listing 32. SUBROUTINE TRCOUT

```

SUBROUTINE TRCOUT(NTRAC,NMAX,MMAX,TRACER,KPRNT,DELY,DELY,IJDUMP)
DIMENSION TRACER(200,3),KPRNT(NMAX,MMAX)
INTEGER BLANK,STAR
DATA BLANK,STAR/3H      ,3H * /
WRITE(6,6002)

C
C***** PRINT OUT LOCATION OF TRACERS IN A MAP
C
      DO 10 I=1,NMAX
        KPRNT(I,1)=I
        CONTINUE
10     WRITE(6,6000) (KPRNT(I,1),I=1,NMAX)
      DO 12 J=1,MMAX
        DO 12 I=1,NMAX
          KPRNT(I,J)=BLANK
        CONTINUE
12
C
C***** FIND TRACER LOCATION AND FILL KPRNT MATRIX
C
      DO 20 K=1,NTRAC
        I=TRACER(K,1)/DELY+2
        J=TRACER(K,2)/DELY+2
        CONTINUE
13     IF(KPRNT(I,J) .EQ. BLANK) GO TO 17
        IF(I .LT. 2) GO TO 15
        I=I-1
        GO TO 13
15     CONTINUE
        IF(KPRNT(I,J) .EQ. BLANK) GO TO 17
        IF(I .GT. NMAX-1) GO TO 19
        I=I+1
        GO TO 15
17     CONTINUE
        ENCODE(3,6003,KPRNT(I,J)) K
19     CONTINUE
20     CONTINUE
C
C***** MARK LOCATION OF DUMPING SITE WITH A *
C
      ID=IJDUMP/100
      JD=IJDUMP-ID*100
      KPRNT(ID,JD)=STAR
C
C***** OUTPUT LOCATION MATRIX
C
      DO 30 J=1,MMAX
        WRITE(6,6001) J,(KPRNT(I,J),I=1,NMAX)
30     CONTINUE
      RETURN
99     CONTINUE
      CALL EXIT
C
C***** FORMATS
C
6000 FORMAT(2X,'M/N',2X,40(1X,I2))
6001 FORMAT(2X,I2,3X,40A3)
6002 FORMAT(1H1,'* TRACER MAP*')
6003 FORMAT(1X,I2)
      END

```

Listing 33. SUBROUTINE DATAWT

```

SUBROUTINE DATAWT
COMMON / R19 / R(19)
COMMON / I4 / I(4)
WRITE(10) R,I
WRITE(11) R,I
WRITE(12) R,I
RETURN
END

```

Listing 34. SUBROUTINE PNORM

```

SUBROUTINE PNORM(ARY,NMAX,MMAX,KPRNT)
DIMENSION ARY(NMAX,MMAX),KPRNT(NMAX)
WRITE(6,6002)

C
C***** FIND MAX/MIN
C
      AMAX=1.0E30
      AMIN=AMAX
      DO 5 I=1,NMAX
        DO 5 J=1,MMAX
          ARYIJ=ARY(I,J)
          IF(AMAX.LT. ARYIJ) AMAX=ARYIJ
          IF(AMIN.GT. ARYIJ) AMIN=ARYIJ
        CONTINUE
      5 IF(AMAX.LT. 1.0E-30) AMAX=1.0E30
        DO 10 I=1,NMAX
          KPRNT(I)=I
        CONTINUE
      10 WRITE(6,6000) (KPRNT(I),I=1,NMAX)

C
C***** NORMALIZE AND PRINT
C
      DO 60 J=1,MMAX
        DO 25 I=1,NMAX
          ARYIJ=ARY(I,J)/AMAX*100.0
          KPRNT(I)=ARYIJ
        CONTINUE
      25 WRITE(6,6001) J,(KPRNT(I),I=1,NMAX)
      60 CONTINUE
      RETURN

C
C***** FORMATS
C
      6000 FORMAT(2X,'M/N',2X,40(1X,I2))
      6001 FORMAT(2X,I2,3X,40(I3))
      5002 FORMAT(1H1,'* NORMALISED CONCENTRATION MAP*/)
      END

```

Listing 35. SUBROUTINE EXTND

```

SUBROUTINE EXTND(NMAX,MMAX,MIDRY,SEP,UP,VP)
  DIMENSION MIDRY(NMAX,MMAX),SEP(NMAX,MMAX)
  * ,UP(NMAX,MMAX),VP(NMAX,MMAX)
  NMAXM=MMAX-1
  MMAXM=MMAX-1
  DO 60 N=2,NMAXM
    DO 50 M=2,MMAXM
      NP=MIDRY(N+1,M)
      NM=MIDRY(N-1,M)
      NW=MIDRY(N,M)
      MP=MIDRY(N,M+1)
      MM=MIDRY(N,M-1)
      IF(NOW .GT. 1) GO TO 40
C
C***** IS WEST CELL DRY-- NP=2
C
      IF(NP .LT. 2) GO TO 10
      SEP(N+1,M)=SEP(N,M)
      VP(N,M)=0.0
    10 CONTINUE
C
C***** IS EAST CELL DRY-- NM=2
C
      IF(NM .LT. 2) GO TO 20
      SEP(N-1,M)=SEP(N,M)
      VP(N-1,M)=0.0
    20 CONTINUE
C
C***** IS NORTH CELL DRY-- MP=2
C
      IF(MP .LT. 2) GO TO 30
      SEP(N,M+1)=SEP(N,M)
      UP(N,M)=0.0
    30 CONTINUE
C
C***** IS SOUTH CELL DRY-- MM=2
C
      IF(MM .LT. 2) GO TO 40
      SEP(N,M-1)=SEP(N,M)
      UP(N,M-1)=0.0
    40 CONTINUE
    50 CONTINUE
    60 CONTINUE
  RETURN
END

```

Listing 36. SUBROUTINE BNDRY

```

SUBROUTINE BNDRY(SEP,NMAX,MMAX,MINDO,NINDO,MORD,NORD,INLET,K,DELT
+ , LONGIT,PHI,MSL,WATLEV,TYME,U,V,RNDU,BNDV,DELY,DELY)
C
C***** CALCULATE NEW SEAWARD BOUNDARY ELEVATION AND STORE IN
C***** RNDJ
C      RNDU IF IR=1 OR 3
C      RNDV IF IR=2 OR 4
C
C      DIMENSION SEP(NMAX,MMAX), MORD(MINDO), NORD(NINDO), U(NMAX,MMAX)
+ ,V(NMAX,MMAX), RNDU(MINDO), BNDV(NINDO)
C
C      REAL LONGIT, MSL
C
C***** GENERATE THE TIDE LEVEL
C
C      CALL TIDE(DELT,LONGIT,TIDLEV,PHI)
C
C      WATLEV = TIDLEV*0.3048 + MSL
C      TYME = TYME + DELT
C
C***** INLET IS THE SEAWARD OPENING (I OR J)*10 + IR
C      IR = 1 NORTHERN OPENING
C      IR = 2 EASTERN
C      IR = 3 SOUTHERN
C      IR = 4 WESTERN
C
C***** NOTE ***** WORK NEEDED HERE TO ALLOW FOR
C                      MORE THAN 1 INLET
C                      I.E. DIMENSION INLET(NINLT)
C
C      MM=MINDO-1
C      NN=NINDO-1
C      IORJ = INLET/10
C      IR=INLET-IORJ*10
C      GO TO (10,20,10,20),IR
10  CONTINUE
C
C***** OPENING IS ORIENTED NORTH-SOUTH (MORD)
C
C      DO 15 M=1,MM
C      I=MORD(M)
C      I1=I/10000000
C      I=I/100000 - I1*100
C      IF(I.NE. IORJ) GO TO 14
C      RNDU(M)=WATLEV
C      GO TO 30
14  CONTINUE
15  CONTINUE
C      WRITE(6,6000) INLET,(MORD(J),J=2,MINDO)
C      CALL EXIT
C
C      20 CONTINUE
C
C***** OPENING IS ORIENTED EAST-WEST
C
C      DO 25 N = 1,NN
C      J=NORD(N)
C      J1=J/10000000
C      J=J/100000 - J1*100
C      IF( J.NE. IORJ) GO TO 24
C      BNDV(N)=WATLEV
C      GO TO 30
24  CONTINUE
25  CONTINUE

```

Listing 36 (concluded)

```

      WRITE(6,6001) INLET, (NOBD(J), J=2,NINDO)
      CALL EXIT
30    CONTINUE
C
      RETURN
6000  FORMAT('====ERROR==SEAWARD BOUNDARY*/' INLET=*,I10,* NOBD=*,5(1X
+ ,I8,1X)/)
6001  FORMAT('====ERROR==SEAWARD BOUNDARY*/' INLET=*,I10,* NOBD=*,5(1X
+ ,I8,1X)/)
      END

```

Listing 39. SUBROUTINE SETBNX

```

      SUBROUTINE SETBNX(IMAX,JMAX,I,J,MIDRY,V)
      DIMENSION MIDRY(IMAX,JMAX),V(IMAX,JMAX)
C
      COMMON /PARAM/ UIJM,UIJP,UIJ,UIJ,UIPJ,VIJ,VIJP,VIJM,VIMJ,VIPJ
+ ,VINJM,VINJP,VIMJM,UIPJM,CIJ,CIJP,CIPJ,HIJ,HIJP,HIJM,HIPJ
+ ,HIMJ,HIMPJ,HIMJM,HIPJM,HIPJP,HSEIPJ,HSEIMJ,HSEIJP,HSEIJM
+ ,XSTRES,YSTRES,SEIJ,SEIJM,SEIJP,SEIMJ,SEIPJ
+ ,CIMJ,CIJM
C
C
C***** IS WEST CALL A DRY BOUNDARY
C
      IF(MIDRY(I+1,J) .NE. 2) GO TO 435
      XSTRES=0.0
      VIJ=0.0
      SEIPJ=SEIJ
      HSEIPJ=(HIJ+HIJM+SEIJ+SEIPJ)*0.5
      UIPJ=UIJ
      CIPJ=CIJ
435    CONTINUE
C
C***** IS EAST CELL A DRY BOUNDARY
C
      IF(MIDRY(I-1,J) .NE. 2) GO TO 437
      XSTRES=0.0
      SEIMJ=SEIJ
      HSEIMJ=(HIMJ+HIMJM+SEIJ+SEIMJ)*0.5
      UIMJ=UIJ
      CIMJ=CIJ
      VIMJ=0.0
437    CONTINUE
      RETURN
      END

```

Listing 40. SUBROUTINE UBND

```

SUBROUTINE UBND(SE,U,V,NMAX,MMAX,MOBD,MINDO,BNDU
+ ,TIDES,NUMTID,MOLA)
+ ,TIDES,NUMTID,MOLA)
DIMENSION SE(NMAX,MMAX),MORD(MINDO),BNDU(MINDO),U(NMAX,MMAX)
+ ,V(NMAX,MMAX),TIDES(NUMTID),MOLA(MINDO)
COMMON /BNDXY/ ULAM,VLAM,TIDEMX
C
C***** RESET NORTH = SOUTH OPEN BOUNDARIES
C
      NUM = 0
10  CONTINUE
      NUM = NUM + 1
      IF(NUM.EQ. MINDO) GO TO 99
      II = MORD(NUM)
      INLET = II/10000000
      II = II - INLET*10000000
      J = II/100000
      II = II - J*100000
      IFIRST = II/1000
      II = II - IFIRST*1000
      ILAST = II/10
      JRND = II-ILAST*10
      KOEF = 1 - 2*JRND
      COEF = KOEF
      JP = J + KOEF
      IF(INLET.LT. 1) GO TO 2
      MOLA=MOLA(NUM)
      DLATID=TIDES(MOLA)
      FACTOR=ULAM*(TIDEMX-DLATID)
      EXPON=EXP(FACTOR)
      UB=BNDU(NUM)*(1.0-EXPON)
      ETAR=0.0
2    CONTINUE
      DO 5 I = IFIRST,ILAST
      V(I,J) = 0.0
      IF(INLET.GT. 0) GO TO 3
C
C***** OPEN SEAWARD BOUNDARY. SET SE(I,J)
C
      SE(I,J) = BNDU(NUM)
      GO TO 4
C
C***** OPEN LANDWARD BOUNDARY. SET U(I,J)
C
3    CONTINUE
      U(I,J)=UB*COEF
4    CONTINUE
5    CONTINUE
      GO TO 10
99  CONTINUE
      RETURN
      END

```

Listing 41. SUBROUTINE VBND

```

SUBROUTINE VBND(SE,U,V,NMAX,MMAX,NORD,NINDO,BNDV
* ,TIDES,NUMTID,NOLA)
* DIMENSION SE(NMAX,MMAX),NORD(NINDO),BNDV(NINDO),V(NMAX,MMAX)
* ,U(NMAX,MMAX),TIDES(NUMTID),NOLA(NINDO)
COMMON /RNDXY/ ULAH,VLAH,TIDEX
C
C***** RESET EAST - WEST OPEN BOUNDARIES
C
      NUM = 0
10  CONTINUE
      NUM = NUM + 1
      IF(NUM.EQ. NINDO) GO TO 99
      JJ = NORD(NUM)
      INLET = JJ/100000000
      JJ = JJ - INLET*100000000
      I = JJ/100000
      JJ = JJ - I*100000
      JFIRST = JJ/1000
      JJ = JJ - JFIRST*1000
      JLAST = JJ/10
      IBND = JJ - JLAST*10
      KCOEF = 1 - 2*IBND
      COEF = KCOEF
      IP = I + KCOEF
      IF(INLET.LT. 1) GO TO 2
      NDLAY=NOLA(NUM)
      DLATID=TIDES(NDLAY)
      FACTOR=ULAH*(TIDEX-DLATID)
      EXPON=EXP(FACTOR)
      VR=RNDV(NUM)*(1.0-EXPON)
      ETAR=0.0
2   CONTINUE
      DO 5 J = JFIRST,JLAST
      U(I,J) = 0.0
      IF(INLET.GT. 0) GO TO 3
C
C***** OPEN SEAWARD BOUNDARY. SET SF(I,J)
C
      SE(I,J)=RNDV(NUM)
      GO TO 4
C
C***** OPEN LANDWARD BOUNDARY. SET V(I,J)
C
3   CONTINUE
      V(I,J)=VR*COEF
4   CONTINUE
5   CONTINUE
      GO TO 10
99  CONTINUE
      RETURN
      END

```

Listing 42. SUBROUTINE UELBND

```

SUBROUTINE UELBND(MORD,MINDO,BNDU,QBNDU,H,SE,NMAX,MMAX,DELY)
  DIMENSION H(NMAX,MMAX),SE(NMAX,MMAX),MOBD(MINDO),BNDU(MINDO)
  + ,QBNDU(MINDO)
C
C***** FIND VELOCITY FOR CONSTANT FLOW
  NUM = 0
10  NUM = NUM + 1
     IF(NUM.EQ. MINDO) GO TO 99
     BNDU(NUM) = 0.0
     IF(QBNDU(NUM).LE. 0.0) GO TO 10
     II = MOBD(NUM)
     INLET = II/10000000
     II=II-INLET*10000000
     J = II/100000
     II = II - J*100000
     IFIRST = II/1000
     II = II - IFIRST*1000
     ILAST = II/10
     JEND = II - ILAST*10
     AREA=(SE(IFIRST,J)+H(IFIRST,J))*0.5*DELY
     DO 20 J=IFIRST,ILAST
        AREA=AREA+(SE(I,J)+H(I=1,J)+H(I,J))*0.5*DELY
20  CONTINUE
     BNDU(NUM) = QBNDU(NUM)/AREA
     GO TO 10
99  CONTINUE
     RETURN
     END

```

Listing 43. SUBROUTINE VELBND

```

SUBROUTINE VELBND(NORD,NINDO,BNDV,QBNDV,H,SE,NMAX,MMAX,DELY)
  DIMENSION H(NMAX,MMAX),SE(NMAX,MMAX),NORD(NINDO),BNDV(NINDO)
  + ,QBNDV(NINDO)
C
C***** FIND VELOCITY FOR CONSTANT FLOW
  NUM = 0
10  NUM = NUM + 1
     IF(NUM.EQ. NINDO) GO TO 99
     BNDV(NUM) = 0.0
     IF(QBNDV(NUM).LE. 0.0) GO TO 10
     II = NORD(NUM)
     INLET = II/10000000
     II=II-INLET*10000000
     I = II/100000
     II = II - I*100000
     JFIRST = II/1000
     II = II - JFIRST*1000
     JLAST = II/10
     JEND = II - JLAST*10
     AREA=(SE(I,JFIRST)+H(I,JFIRST))*0.5*DELY
     DO 20 J=JFIRST,JLAST
        AREA=AREA+(SE(I,J)+H(I,J=1)+H(I,J))*0.5*DELY
20  CONTINUE
     BNDV(NUM) = QBNDV(NUM)/AREA
     GO TO 10
99  CONTINUE
     RETURN
     END

```